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MEDICAL CLIMATOLOGY AND BALNEOLOGY.

By GEORGE H. ROHÉ, M.D.,

BALTIMORE.

CLIMATOLOGY.

1. *General Considerations.*—The scientific study of climatology has been undeservedly neglected by English-speaking nations. There is not a single systematic work at command of those conversant with English only which gives an account of the present state of the science. Those who wish to study climatology either in its purely physical or in its biological relations are obliged to resort to German, French, or Russian authorities. Within the last few years the medical aspects of climatology have received some attention at the hands of American and English physicians; but with few exceptions the productions of these authors have been based upon insufficient acquaintance with the elementary principles of the science, or have been so strongly colored by local prejudices or by a commercial element that the deductions or inferences drawn must be subjected to many corrections before they can be accepted.

The only complete systematic work on physical climatology issued from the press during the year 1887 is the German edition of Dr. A. Woeikof's great treatise on "The Climates of the Earth."[1] These two volumes form the most thorough and complete treatise upon climatology now accessible, and should be in the hands of all earnest students of the science. It is to be hoped that some enterprising American publisher will soon give American students an opportunity of reading this work in the vernacular. An accurate translation revised by some competent scholar familiar with the climatic peculiarities of the North American Continent would be a boon to the student of climatology, and ought to prove a profitable investment for the publisher.

In his address as President of the section on Climatology and Demography in the Ninth International Medical Congress, Dr. A.

L. Gihon[2] considered the points of contact between purely physical or geographical, and medical climatology.

The influences properly comprehended under the term climatology are atmospheric, telluric, and cosmic. Latitude, altitude, distance from the ocean, and prevailing winds are the chief elements of geographic climate. There is, however, no uniform understanding among physicians as to which are properly climatic characteristics, or merely vicissitudinal occurrences. Paludal malarial infection, being remedial by drainage, is contested by some not to be a proper attribute of the climate of a locality. The genius of man can undoubtedly bring about the changes upon the face of nature which will make the marsh no longer the home of the malarial germ.

The effects of climate are not to be looked for in the prevalence of specific diseases with well-defined geographic limits. Many of the diseases attributed to climate have been due to local insanitary causes.

What climate chiefly does is to establish constitutional tendencies through molecular modifications which become permanent and morbific if its warnings are disregarded or opposed, but are as often therapeutic and curative when intelligently conformed to and heeded.

These opinions are in a measure a reflex of the views of Lombard, the father of modern medical climatology, widened and more accurately defined by many years' close observation in all quarters of the globe. Dr. Gihon also observes that in the medical curriculum in which climatology demands a place as a subject of study beside hygiene and pharmacological therapeutics, there can be no room for the teaching of elementary meteorology. However, at the present day the instruction in meteorology in scientific schools and colleges is so defective that even though the medical student should be a graduate in arts, he is not in a position to profit by a course of lectures on medical climatology unless some elementary instruction precedes.

The same subject was discussed from a somewhat different standpoint by Rohé. Some defects in the present modes of observation and registration were pointed out. The medical climatologist must be a student of meteorology, and something more. The question, what constitutes climate? cannot in a medical point

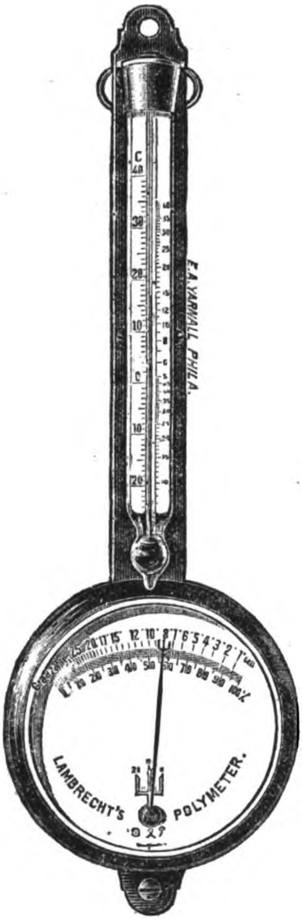
of view be definitely answered. The medical climatologist cannot be satisfied by simple records of atmospheric pressure, temperature, humidity, precipitation, cloudiness, winds or amount of sunshine. He must, in addition to being a meteorologist, be a student of preventive medicine, epidemiology, climato-therapy, geography and ethnology. Climate must be studied in its bearings upon the individual in health as well as disease, as also in relation to the occurrence or propagation of specific or non-specific diseases. The causes of the sanatory and morbific effects of climate must be sought not merely in meteorological changes, but the study of these problems must be pursued with a broader scope than heretofore. For example, while the recorded atmospheric phenomena must form the basis, other conditions, such as those of the soil, must also be taken in account. In studying the most characteristic climatic diseases, such as cholera, yellow fever, and climatic dysentery, an intermediate factor, namely, the special virus of the disease, must be considered. A hot climate alone will not produce the diseases mentioned.

Varying meteorological conditions may, however, produce effects upon the organism which are sometimes beneficial, often otherwise.

The effects of greatly diminished pressure upon the human organism are well known. Paul Bert and others have shown that these effects are not merely due to the physical conditions of diminished pressure, but that the relative diminution of oxygen in rarefied air is an important factor in their production. While cases of phthisis usually do well in a moderately rarefied atmosphere, the effects of diminished pressure are not always beneficial, as has been pointed out by Dr. Loomis,[3] who warns against the danger of sending patients with heart-disease to high altitudes. It is not probable that diurnal or accidental variations of pressure have any appreciable influence upon health. Investigations conducted by the writer have failed to yield any positive results.

The primary classification of climates into tropical, temperate and polar indicates the influence ascribed to temperature as a climatic factor. Although recent writers have attributed a determinate climatic influence to humidity, it is probable that this is of far less importance than some have supposed. The temperature must still be regarded as our best index of climate, but too much

dependence must not be placed upon it. Many of the unfavorable effects attributed to moisture of the atmosphere ought to be ascribed to coincident insanitary conditions. The sanatory or morbific effects of air-currents have not been sufficiently considered heretofore.



LAMBRECHT'S POLYMETER.—
Deut. Med. Zeit.

The tendency among climatologists at present is to deny to ozone any sanatory or disease-producing influence. Hydrogen peroxide is believed to be an antiseptic agent of importance in the atmosphere by some clinicians, who also ascribe therapeutic effects to the aromatic exhalations of certain plants. This has received especial attention from Loomis, and will be more fully considered on a subsequent page of this report.

The climatologist should be a practical meteorologist. The acquisition of an elaborate collection of instruments and their regular observation is too expensive and time-consuming. Lambrecht[4] has devised a combination instrument which combines in itself many excellencies and nearly all the requirements of a trustworthy meteorological instrument. The polymeter, as it is called (see figure), shows the temperature, the relative humidity, dew-point, absolute humidity in grammes per cubic meter and vapor tension. Troska has supplied a set of weather rules which are furnished with the instrument. The price is 20 to 36 marks ($5.00 to $9.00 exclusive of duty). Any mathematical instrument maker should be able to furnish this handy apparatus.

II. Climate and Disease. The Question of Acclimation.—With reference to these important problems some papers of value have been contributed during the year. The colonization schemes of the French and German Governments in Asia and Africa have

given occasion to several very thorough studies in tropical climatology and hygiene, by European writers.

Nicolas[6] has an elaborate review, based upon d'Ormay's Report of the Medical Statistics of French Cochin China for the period 1863–1870. The review is in the nature of a monograph, but is not easy to give in abstract. It is interesting to note a point with regard to the distribution of diseases to which attention is called in the article. The bad *season* in the zone between 8 and 12 degrees of N. latitude is usually the season of rain, which lasts from May to December. In Cochin China malarial fevers are most prevalent during the rainy *season*, yet the bad *years* are the dry ones. The mortality is greater in dry than in wet years,—a fact also noted for this country by Dr. Day, of Louisiana, and others. In wet years the mortality is less if the heat is less; nevertheless high temperature with high humidity is always less fatal than a dry high temperature. This result is unexpected, but the figures show it to be correct. In 1870, an exceptionally wet year, the mortality in Cochin China did not exceed 4 per cent., while in 1863 and 1864, the dryest years known for 40 years, the mortality was respectively 6.3 and 5.4 per cent. In 1865, hot and moist, the mortality fell to 4.8 per cent., in 1866, wetter and less hot, it decreased to 4.4 per cent., and in 1867, very hot and dry, it again ascended to 6.1 per cent. Some comparative statistics given also occasion surprise. We have been led to believe that Tonquin is almost the most unhealthy spot on the globe; but Nicolas tells us that the mortality is 4.5 per cent. in Cochin China, 7.7 per cent. in Senegambia, 9.7 per cent. in Panama. Paludal fevers are the prevalent diseases of the rainy season. They spare neither natives nor strangers. In Cochin China the natives usually suffer from the tertian forms, while Europeans are attacked by the quotidian.

Natives, however, suffer to a less degree than Europeans. Among the white troops the daily admissions to hospital are 82.2 per 1000, while among the native troops the admissions are only 19.8 per 1000 of effective strength.

In Senegal, while the admissions of blacks to the hospital are only one-third that of the whites, they remain five times as long, and the death rate is 132.8 per 1000, as against 119 per 1000 among the whites.

The question is an important one in view of the present

colonization enterprises. European civilization tends more than ever to force the barriers of the tropics. Railroads laid by European hands penetrate the steppes, the marshes, the virgin forests. Agriculture timidly follows industry and everywhere the work is being prosecuted under the protection of hygiene. If, in the language of Bordier, the white race is the only one that has the genius of colonization, this protection is necessary. In our days a new science is growing,—that of sanitary economy. Man is being recognized as valuable capital and worthy of being saved from death, not only from a humanitarian, but from a pecuniary point of view. This is, however, not yet sufficiently recognized, even among enlightened nations. The governments of the world are but slowly appreciating the economy of health.

Rey[6] contributes an excellent article on the climatology of Tonquin. From May to the end of September, Tonquin is one of the hottest and rainiest countries in the world. May and June are hardest to bear. The sun is in the zenith and the copious daily rains fail to cool the atmosphere. Throughout the summer physical exercise is impossible, intellectual labor difficult. One is drowsy, overwhelmed by the heat and moisture of the atmosphere, inundated by perspiration which no evaporation seems to diminish. The pankah is a necessity. One can get no good sleep without the aid of repeated cool baths. A walk is only possible in the early morning or late in the evening. During the period of greatest heat the difference in temperature between day and night is only 3–4 degrees C. Toward the end of August the mornings are relatively cool and the nights supportable.

Generally in September a tornado announces the end of the hot season. The mornings show a temperature one degree less than the previous month, but this small difference is agreeably appreciated by those who have lived through the heat of the summer. In October the north and northeast winds bring true autumnal days, tonic temperature and blue, sunny skies. The mountains are of a deep violet. The dormant intelligence awakens. It gives one pleasure to do mental work. Toward the end of the month it is possible to resume the physical exercises interrupted by summer. November begins the winter. Hunting, riding and walking are pleasant exercises. The nights are cool. The thermometer falls to 16° C. (=61° F.) A fair sun rejoices

the eyes. The rains are over; the month is characterized by relative dryness; there are only fine rains or fogs which reach but half way to the tops of the hills.

As the north and northeast winds predominate in December, and their tonic effects are appreciated, the body regains its vigor and the stomach its European appetite. About the middle of the month, with a temperature of 14 degrees C. (57° F.), the agreeable tropical breezes begin, which render the chase and walks in the country delightful. Toward the end of the month, with cloudy skies and fine rain, and a temperature of 10 degrees C. (50° F.), one wants a fire in his apartments.

January is the coldest month in the year. The fires are kept up all day and woolen clothing is necessary. February is the month of fogs. It is characterized by a constant mist and penetrating humidity. The water collects in drops on the walls of the rooms, and a fire is necessary in order to keep dry. Day after day shoes and all objects of leather are covered with moisture. In March the temperature increases with cool intervals. Exercise becomes irksome and brings out the perspiration. April is likewise very humid; the heat increases, and while at the beginning of the month walking in the middle of the day may yet be indulged in, toward the last days of the month one takes his promenades a little before bedtime. By the 25th the southeast wind has become well established, and the broiling monotony of the tropical summer is again at hand.

Summing up, the European finds in Tonquin five good months, from November to the end of March; five bad months, from May to the end of September; and two tolerable months, April and October.

The temperature ranges from 8 degrees C. (47° F.) in January to 36 degrees C. (97° F.) in July: a total range of 28 degrees C. (50° F.)

Morand[7] also contributes an elaborate memoir on the climate and diseases of the delta of the Red River in Tonquin. After giving a table of temperatures at the post of Nam-Dinh, the author says: "These temperatures (maximum 36 degrees C. 97° F.) are not excessive; but what renders them exceedingly hard to bear is the extreme humidity. The anæmia and depression of the vital powers produced by the summer heat causes an extreme sensitiveness to the cold of the winter. After one has passed a year in Tonquin, when the thermometer falls to 12 degrees C. one builds

a fire if one is fortunate enough to have a chimney in his room. If not, one freezes!"

The diseases prevailing in the various months are: January, February and March, generally healthy, bronchitis, rheumatisms, simple diarrhœas, and malarial fevers; toward the end of March, dysentery recurs; April and May fairly healthy, malarial fevers increasing; in May, affections of the liver appearing; June and July bad months; increase in cases and deaths. Predominant diseases, malarial fevers, dysentery, typhoid fever, congestions of the liver and diarrhœas; in August and September the same diseases prevail, but are less frequent; by November zymotic diseases have disappeared; and in December the diseases due to cold occupy most of the space in the sick report. Out of a mean effective strength of 380 Europeans, 33 died during 1885. The yearly morbidity was 389, or 1.02 per man.

Professor Treille[8] delivered an address upon acclimatization at the Sixth International Congress of Hygiene and Demography at Vienna. The author denied that Europeans were unable to colonize hot countries. The entire secret of success is in overcoming certain obstacles; and in order to attain this result we must know the influence of the meteorological conditions of hot climates upon the human organism. He believes that the high absolute humidity to a greater degree than the temperature causes the increase of respiration, heightened blood pressure, increased transpiration and hyperthermia. The higher the vapor tension the less the air pressure; hence insufficient tension of oxygen and consequent deficient oxidation of the blood. The higher the vapor tension the less the exhalation from the lungs and the skin; hence increase of the serous portion of the blood, progressive hydremia, retention of heat, and tendency to abnormally high temperature.

The retention in the blood of a quantity of water, which is ordinarily exhaled by the lungs, increases blood pressure. In consequence there is an overfilling of the already dilated cutaneous vessels and hyperidrosis. This increases thirst and compels the ingestion of large quantities of fluid. By this overfilling the pressure in the portal system is increased, hepatic swelling and tendency to polycholia follow. The muscular power of the stomach is weakened by the large quantities of fluid, the digestion delayed and nutrition depreciated.

The rules to be observed in acclimatization comprise the proper selection of a locality, improvement of the soil, construction and arrangement of dwellings, selection of clothing, regulation of the mode of life in general, and tropical hygiene. The following propositions were submitted and adopted by the Congress:—

1. It is desirable that meteorological stations be established in hot countries whose task shall be to determine the value of certain climates, particularly as regards the temperature and the role of aqueous vapor, as well as the influence of winds upon the composition of the atmosphere.

2. It is necessary that European countries which have emigration agencies shall compel these to furnish every emigrant going to a hot country instructions concerning the hygienic precautions to be adopted on arrival.

3. These instructions shall bear particularly upon clothing, dwelling and nutrition.

4. The professors of hygiene are requested to devote attention to the hygiene of tropical and subtropical countries, in their lectures.

Metzgar,[9] writing upon the climate of the Dutch East Indies, states that the climatic conditions of Java forbid the expectation that there may ever be a prosperous and healthy population of unmixed European ancestry in that island. Malaria is prevalent even at altitudes of 2000 to 3000 feet. Women suffer more from the effects of climate than men. In Sumatra, according to Paster,[10] similar conditions prevail. Malaria, dysentery, fatty degeneration of the heart and increased nervousness is noted in every European who has been in the island for any length of time. If exhausting labor is not performed and a rational mode of life adopted, Europeans may live from three to ten years. Beri-beri is frequent among the soldiers.

Baelz[11] reports upon the climatology and demography of Japan. The temperature averages 13° C. This is somewhat enervating in summer, and acts unfavorably on nervous persons, rheumatics and consumptives. Marriages among Europeans in Japan are very prolific. The climate seems to be wonderfully favorable to infant life. Twenty-six births were reported to the German consulate in Tokio in 12 years, and during this time only one death under five years occurred among the German popula-

tion. The English consulate during the same time reported seventy-six births, and one death under five. Malaria, dysentery, typhoid fever, diphtheria, scarlatina, measles, venereal diseases, leprosy, beri-beri and consumption are prevalent. Among Europeans aneurism of the aorta is frequent. Hemorrhages from the lungs are frequent, due to the presence of a parasite (distoma pulmonale). The patients may expel blood and worms daily for years without feeling ill or presenting any evidence of anæmia.

Buchner[12] gives the result of his observations in the Congo Basin and in Cameroon. Fever is everywhere prevalent in Africa. It is not only fatal to Europeans, but also to natives. Mahli[13] and Nipperdey[14] come to the same conclusion. The Soudan and the Somali country are likewise fever-stricken regions.

On the other hand, DeGroote[15] considers the climate of the Congo country healthier than that of Brazil, or of either the English or Dutch Indies.

The climate of New Guinea is said by Rev. W. G. Lawes[16] to be entirely unfitted for colonization by the white race. No part of New Guinea is free from fever. This fever "has much in common with malarial fevers, but there are characteristics which distinguish it. The remittent type is most prevalent, and most difficult to deal with; but there is another form which seems to partake of both the intermittent and remittent type. No age or condition is free."

Haviland[17] has found that in the districts of England and Wales where the prevailing winds followed the direction of the valleys and not athwart them, there was the least amount of heart-disease and rheumatism. Where winds blew over the valleys and allowed stagnant air to remain in the bottom, heart-disease was at its maximum. Cancer was most frequent "where the riparian districts of fully formed rivers were seasonably flooded." Consumption was most frequent in districts exposed to the full blast of the wind without protection. He advocated the cottage-plan of treating consumption, the cottages being selected in healthy localities. He condemned consumption hospitals.

F. Donaldson, Jr.,[18] calls attention to the causes of cardiac failure at high altitudes. Loomis[19] has already pointed out the danger of sending patients with heart-disease to the mountains. Donaldson asserts that in the pneumatic chamber conditions similar

to those at high elevations are produced, and cautions against careless treatment of such patients in the cabinet. His experiments have shown, contrary to those of Paul Bert and others, that the cause of heart-failure at great elevations is not diminution of oxygen, but the diminished pressure. According to Donaldson's experiments there is sufficient oxygen in the air inhaled to supply the hemoglobin at any altitude within 10,000 feet. In ascending to high altitudes the pressure of the air within and without the lungs is the same; but on the heart the action is different. The pressure is removed from the outer surface of the heart while the internal blood-pressure remains the same. Hence dilatation of the heart-walls must follow.

Lewis[20] has studied the relations of meteorological changes to chorea, rheumatism and neuralgia. He analyzed 437 attacks of chorea and 467 attacks of rheumatism, which were noted in Philadelphia. The months of onset of the attacks were recorded as follows, for chorea:—

January,	36 attacks,	8.2 per cent.
February,	33 "	7.5 "
March,	67 "	15.3 "
April,	38 "	8.6 "
May,	47 "	10.7 "
June,	40 "	9.1 "
July,	46 "	10.5 "
August,	34 "	7.7 "
September,	27 "	6.1 "
October,	18 "	4.1 "
November,	19 "	4.3 "
December,	32 "	7.3 "

The 467 attacks of rheumatism are distributed as follow:—

January,	50 attacks,	10.7 per cent.
February,	45 "	9.4 "
March,	45 "	9.5 "
April,	81 "	17.3 "
May,	48 "	10.2 "
June,	32 "	6.6 "
July,	28 "	5.9 "
August,	26 "	5.5 "
September,	29 "	6.2 "
October,	28 "	5.9 "
November,	24 "	5.1 "
December,	32 "	6.6 "

The number of storms passing within a radius of 400 miles from Philadelphia during ten years was then studied and the following distribution in the different months was found to exist:—

January,	60 storms,	11.5 per cent.
February,	54 "	10.3 "
March,	75 "	14.0 "
April,	46 "	8.8 "
May,	41 storms,	7.8 per cent.
June,	28 "	5.3 "
July,	34 "	6.5 "
August,	19 "	3.6 "
September,	24 "	4.6 "
October,	32 "	6.1 "
November,	47 "	9.0 "
December,	60 "	11.5 "

These tables show a marked coincidence between the time of onset of attacks of chorea and the passage of storms, while as a rule the onset of attacks of rheumatism occurred one month later. Incidentally this study also showed the coincidence of frequency of attacks of neuralgia with the onset of chorea, the records of the case of Capt. Catlin[21] being used for comparison.

Proceeding on the plan first outlined by Dr. H. I. Bowditch[22] in his epoch-making researches thirty years ago, Dr. Wm. Pepper[23] has studied the climatological relations of phthisis in Pennsylvania. His results tend to confirm those arrived at by Dr. Bowditch, namely, that dampness of the soil has an intimate relation to the prevalence of consumption. All the counties in Pennsylvania with high mortality from consumption have very little elevation, and further are situated in the areas of largest annual rainfall. Those portions of the State where phthisis is rarest are the most elevated, having a general altitude from 1500 to 3000 feet; areas of higher mortality from consumption coincide in a measure with areas of increased rainfall. Elaborate maps and tables accompany the original paper, to which reference should be made.

III. Climato-Therapy. — Pulmonary affections: bronchitis, asthma and phthisis claim by far the largest share of the attention of writers upon the climatic treatment of disease. This is to be expected from the resistance of such diseases to the usual methods of treatment, and the beneficial results often following a change of climate by those affected.

Writers on climato-therapeutics, however, are prone to treat the subject in a one-sided manner. Whether from preconceived notions, insufficient knowledge, local prejudices, or, as appears to be sometimes the case, business considerations, many of the sanatoria are described as veritable gardens of Eden, while those of opposite climatic characters are held to include all malefic tenden-

cies in a concentrated degree. This partisan manner of treating a scientific question is a great evil; and physicians, even though personally interested in the development of this or that health resort, should remember its objectionable features as well as the advantages of some other locality whose interests may be at variance with their own. When the majority of those who write upon the climatic treatment of disease learn to look upon the subject without personal preferences, and study it in a purely scientific and objective manner, this source of complaint will be removed. The reader, anxious to discover the best resort to which to send his patient, will then find that the pure, rarefied atmosphere and sunny days of Colorado have an unpleasant accompaniment in the sand and dust storms which are so frequent; that the fascinations of life in the Riviera and the Mediterranean coasts and islands have their sting in the mistral of Southeastern France, the sirocco of Sicily and the Italian peninsula, and the bora of the Adriatic; that the Alpine resorts have their south wind, or "föhn;" that the California coast is not rarely encompassed by fogs; and that Florida climatically is not altogether a paradise on earth.

Climato-therapy shows signs of emerging from the sea of uncertainty which has threatened to swamp it, and is arriving at that stage where differentiation is possible. It must become the aim of medical climatologists to indicate those climates which are likely to prove beneficial to individual cases. The literature for 1887, reviewed in the following pages, will furnish many facts from which trustworthy conclusions can be drawn.

A general summary of desirable climatic elements at health resorts is given in a lecture by Assmann before the Berlin Medical Society. The first property to be required is that the air shall be pure and, as far as possible, free from dust. This is found at the sea-shore, in forests and in the mountains. The air of mountains has an additional advantage in being almost free from bacterial germs of various sorts, non-pathogenic as well as pathogenic. Ozone should also be present in the air of health resorts. Unfortunately, however, our knowledge of atmospheric ozone is at present in a very uncertain state.

Sufficient ventilation or change of air is also required. This may be secured both at the seaside and at mountain tops. In valleys, forests and protected plateaus, the atmospheric change is

much less. In sending patients to high altitudes in order to obtain the special effects of decreased pressure, regard should be had to the deficiency of oxygen in the air at great heights. As a general rule an altitude of 6000 to 7000 feet should not be exceeded.

Greater range of temperature is found in the mountains, equability on the sea-coast. High relative humidity is found at the sea-shore, in forests and enclosed valleys. Greater variations of relative humidity are met in the mountains. Cloudiness and rain are not absolutely unfavorable. Rain at frequent intervals may have a sanitary influence in washing dust out of the atmosphere and preventing its being carried about in strong wind-currents.

Meteorological observations regularly made are an important part of the scientific work to be done at every health resort; but these observations should be carefully and honestly made; otherwise they have no value.

Dr. B. W. Richardson[25] is nothing if not picturesque. In a recent paper he proposes that British invalids be given at home the sanatory advantages which they can now only secure by resorting to subtropical climates in winter. Man can, he says, compete with nature in the matter of climate; and so far as steadiness is concerned he can beat her. Our houses are kept at a pretty uniform, moderate temperature all winter. "If one room eighteen feet square can be kept all through a very sharp and severe winter at mild summer warmth, why cannot a court eighteen yards square be kept in the same condition? and if a court eighteen yards square, why not a town eighteen hundred yards square, if that were wanted?" It is only a question of degree and can easily be accomplished. He suggests that there are facilities in England attainable by which a hundred winter towns may be built in Great Britain "that shall defy and beat nature on her own ground."

The plan consists of fifty or more two-storied houses, arranged around a square which shall be covered with glass and kept at an equable temperature by artificial-heating apparatus. The square would be "large enough for lawn-tennis, bowls, billiards, lawn-billiards, croquet, and a variety of other games and physical exercises of every description." The houses should be divided into two flats, each of which could be suitably fitted up for an invalid and the necessary attendants. "On the roofs of these flats would be four galleries or terraces, covered in glass and laid out with flowers,

each gallery twenty yards wide and upwards of one hundred long, —in all a promenade round of nearly a quarter of a mile."

But this is not all. In order that there may be no monotony at such a winter palace, there shall be "a library, a reading-room, a lecture-room, a concert-room and theatre, a gymnasium, all the most approved baths, including swimming-baths;" and it would doubtless be a fastidious invalid, as Dr. Richardson suggests, who could not spend the winter months in such a place for the sake of health.

In this winter palace there shall be no cloudy weather. The sun shall shine all the time. If fogs, mists, or clouds obscure old Sol, an electric sun could be made to shine at pleasure.

The enthusiastic author believes that if one such palace were started there would soon be palace villages of four hundred houses or more, with many additional advantages such as cricket-fields, cycle-courses, and horse-exercise grounds, all under genial summer life. Even entire valleys might thus be roofed over with glass "so as to become, in all their natural beauty, gardens of perpetual summer, with miles of park verdure and pleasance."

After this architectural and climatic rhapsody one is somewhat taken aback to find a suggestion by the same author which is full of solid common sense. He advocates the formation of "camps of health" on high levels, where dry, light, and bracing air is obtainable. There are a number of places called "Roman Camps," in England, which are admirably suited for this purpose. These encampments are squares enclosed within embankments and usually cover an area of from eighty to one hundred acres. As the site is always an elevated one, drainage could with little difficulty be made perfect. Pavilions could be built with all necessary conveniences, and thus English invalids could obtain the benefits of mountain air without leaving their native soil. In Scotland and Ireland similar locations exist which could easily be converted into health camps.

Dr. A. L. Loomis[26] holds the opinion that evergreen forests are curative in phthisis, and expresses his belief that the effect is due to the antiseptic character of the air of such localities. The chemical combinations between the volatile emanations from pines and the atmosphere, are regarded as the agents which produce the antiseptic effect. Whatever benefit is derived from the inhalation of the atmosphere of pine forests must be ascribed either directly or

indirectly to the turpentine contained in such air. Dr. Loomis is convinced that the air of pine forests is a most valuable antiseptic and corrective agent for cleaning lung cavities, correcting putrefactive changes, and arresting the multiplication of bacteria. He advocates the cultivation of evergreens in the vicinity of residences, so that we can always be surrounded by an antiseptic atmosphere.

Dr. J. A. Lindsay[27] asks and answers four questions:—1. Does climate cure phthisis? 2. How does climate cure phthisis? 3. What climates cure phthisis? 4. What cases of phthisis are curable by climate? To the first question he answers, yes; recovery, both complete and conditional occurs after sufficiently prolonged residence in a favorable climate.

Climate cures phthisis, not usually by a single or specific quality of the air or by any definite combination of meteorological conditions. "Healing air" is a delusion. Balsamic emanations of pine forests have but slight if any influence (vide Loomis, supra). Climatic treatment cures phthisis by removing the consumptive from the evil influences of unfavorable meteorological conditions and of an injurious soil, and by transferring him to a climate where fresh air, sunshine and outdoor life may be freely enjoyed, and where in consequence the processes of respiration, digestion and sanguification proceed with sufficient energy to combat successfully the hereditary tendency or individual proclivity to pulmonary disease.

Lindsay classifies the climates or health resorts alleged to cure phthisis into three classes; the marine resorts, the dry inland resorts, and the mountain resorts.

The best marine resort is a sea-going ship. Sailing vessels are preferable, and no consumptive should go to sea for his health unless he can command the comforts of a roomy cabin and suitable companionship. The voyage to Australia or New Zealand, via the Cape of Good Hope, is advised as best adapted. Time of sailing should be in July and August, in order to reach the southern hemisphere during spring,—the best and most healthful time. A sea voyage does not exclude hemorrhagic cases. (Vide J. C. Wilson, infra.)

The best marine climates next to a ship are Madeira, Teneriffe, the Azores, Nassau, etc. Diarrhœal cases should not be sent

to Madeira. Other marine resorts, dryer and more tonic, are Algiers, Tangier and Malaga. The reputation of the Riviera is on the wane. Mentone, San Remo and Cannes are the best of the stations in the Riviera. Ventnor, Bournemouth and Torquay are the best marine resorts in England, and Glengarriff in Ireland. Santa Barbara is the best Southern California resort. The north and northeast coasts of Tasmania possess one of the brightest, mildest and most genial climates in the world for consumptives.

The best dry inland resorts are Nubia, the interior of Algeria, the Orange Free State, and the interior plains of Australia. The chief mountain sanatoria are Davos, Wiesen, St. Moritz and Maloja in the Alps, Colorado Springs and Manitou in the Rocky Mountains, Bogota, Janja and Huancayo in the Andes. The winter climate of the high Alps and of the Rockies is similar, being marked by perpetual snow and severe frost. In the equatorial Andes the climate at high altitudes is one of perpetual spring, humid, warm and vernal. The mountain resorts have proved most efficacious in the following cases:—delayed recovery from pneumonia with threatened tuberculosis, chronic pleurisy with much fibroid change, incipient catarrh of the apex, chronic tubercular phthisis, with good reaction and the retention of fair constitutional vigor, whether cases of primary disease limited in extent or single cavity cases without tendency to extend. Hemorrhagic cases do well. (Vide Denison, infra.) Contra-indications are: weak circulation, senile change, erethic constitution, extreme debility and marked progressive emaciation.

Speaking generally, only chronic cases with fair reaction are suitable for climatic treatment. If the disease has a well-defined onset and threatens to run an acute or subacute course; if the patient steadily loses ground and shows no gain in weight or other sign of rallying under treatment; if the process in the lung is progressive and there are no evidences of repair, in each and all of these cases the interests of the patient will be best served by vetoing climatic treatment. In early, uncomplicated cases, with vigorous circulation, mountain climates offer the best hope. If the circulation be feeble or if there be much nervous irritation, the choice will lie between the sea voyage and residence in such dry inland resorts as Upper Egypt or the interior plains of Australia. The sea voyage has the great recommendation that it rarely does harm,

except in those very advanced cases which are beyond the reach of all treatment. If the patient objects to the mountains or a sea voyage, Algeria or Morocco should be preferred to France or Italy. Climatic treatment must be supplemented by proper therapeutics and dietetic management if the best results are to be secured.

A. E. Drysdale[28] discusses the choice of a winter climate for invalids. He advises that incipient phthisical cases should be sent to elevated places, such as Davos Platz or Pontresina. They must go after the snow covers the ground and leave before the thaw commences in the spring. A voyage to Australia, then a residence in the interior of that continent, is advisable for some. The coast climate of Australia is unsuited to consumptives. Persons subject to severe sea-sickness should not be sent on an ocean voyage if avoidable. Hereditary cases, with a tendency to hemorrhages, should be sent to the Riviera, where they are easy of access to their friends (vide Lindsay, supra, and Wilson, infra). Elderly persons suffering from frequent bronchitic attacks also do well in the Riviera during the winter, where they can live much out-of-doors. Heart cases and catarrhal renal diseases are benefited by a mild winter climate.

In an elaborate paper read before the International Medical Congress, Denison[29] has studied the preferable climate for phthisis. He believes that the climate to be preferred for the great majority of consumptives in the United States varies between 1500 feet elevation in the North in winter, to 10,000 feet in the South in summer. Certain contra-indications exist against sending patients with consumption to high altitudes. The physician who takes the most factors into account and weighs them best will be the most successful in the management of each individual case. With this broad proviso, the following may be stated as general contra-indications to an otherwise preferable high climate:—

1. The coldest season of the year intensifying the effect of altitude.

2. Advanced age of the individual rendering acclimatization difficult.

3. An excitable nervous temperament aggravating the stimulation of climate, producing irritability and sometimes wakefulness.

4. Women for a like susceptibility, and less adaptability to the change and to outdoor life than men.

5. Valvular lesions with rapid action of the heart, especially with the previous exceptions.

6. Marked and extensive emphysema, pneumothorax and hydro-pneumothorax.

7. Active pneumonia or existing hæmoptysis. If these are recent the contra-indication is much less than if present; if remote and without other objections, these diseases are most favorably influenced by the change. If there is reason for some doubt in any such otherwise favorable case, a gradual rise in elevation should be chosen.

8. High bodily temperature, whether it be rather constant, as in some inflammatory states, or in catarrhal extension beyond a tubercular zone, or whether it be regularly oscillating as in tuberculous infection,—*i. e.*, daily low or subnormal in the morning and up to 103 degrees or more, later in the day, especially with suspicious laryngeal complication.

9. Extensive involvement of lung tissue in diseased action,—*i.e.*, so that the healthy spirometrical record is more than one-half abridged. Of course advanced age of disease renders this contra-indication much stronger.

10. The stage of softening, if accompanied by marked pyrexia, or in one of decided hemorrhagic diathesis.

Allowing patients to go to Colorado, which many physicians have done, as a *dernier ressort*, when they have not five per cent. of chances of living more than six months anywhere, needs strong condemnation. It must be remembered that every rule has its exceptions, and that contra-indications may be neutralized by favorable circumstances, such as the best time of year for the change, previous experience of the individual in high climates, and the association of opposite conditions in the same patient.

In the climatic treatment of phthisis he thinks the following conditions are preferable: 1, dryness as opposed to moisture; 2, coolness or cold preferable to warmth or heat; 3, rarefaction as opposed to sea-level pressure; 4, sunshine as opposed to cloudiness; 5, variability of temperature as opposed to equability.

Dr. J. W. Robertson[30] gives a full and apparently unprejudiced account of the climate and health resorts of California. The coast presents much uniformity of temperature owing to the constant westerly winds laden with the warm vapors of the Japan

current. From Santa Barbara 300 miles south, to Crescent City 300 miles north of San Francisco there is a mean annual difference of only five degrees. Isothermal lines along the coast run north and south, marking out three climatic belts, named by Robertson the coast, valley and mountain climates.

The coast climate extends several hundred miles north and south, and reaches from five to twenty miles inland.

The valley belt, beyond the coast range commencing with Shasta Valley on the north, extends down through the Sacramento and San Joaquin Valleys into the arid plains of the Mojave and Colorado deserts, while the mountain climate includes the Sierra Nevada beyond. Rainless summers characterize all these regions.

The characterization of the coast climate is no less eloquent than just. The author says: "A coast climate extending through eight degrees of latitude, where snow is phenomenal and frost rare, where the mean daily, monthly and annual temperature varies within a few degrees only, where the bright, sunshiny days are the rule and sultry ones unknown, where the fresh salt air so invigorates as to prove an exhilarating tonic, and where flagging energies and a toneless system are revivified and thrown into a state of the highest tension, commands recognition. To every picture there is and should be some dark lines. In our enthusiasm we often forget to mention the fogs which float in from the ocean and enwrap us with a chilling embrace; that the breeze which so intoxicates us, and which by long habit we have learned to call bracing, searches the marrow-bones of the unacclimatized and sends cold chills through the enfeebled frame of the invalid. This holds true of that region only which is north of Point Conception and which is directly on the ocean.

"Climatically speaking, the therapeutic area of Southern California is small. It is limited to those localities only which are directly influenced by the ocean breeze and extends but a few miles inland. The majority of invalids look to Los Angeles as to a new Mecca. This climate speaks so strongly for itself, it is so mild and delightful, that the most cavilling cannot find fault, and the individual susceptible to the slightest chill utters no complaint.

"The Livermore, Santa Clara, Napa and Santa Rosa Valleys approximate in their climates that of Southern California, and are

fast being occupied as summer resorts. The country is fertile, bearing grapes and other fruits and flowers in great profusion. In summer the thermometer may register seventy or eighty degrees at midday, but such heat is exceptional. The mornings and afternoons are never sultry and the nights are cool. There is no evening fog. During the winter frost occurs but rarely, and snow and ice are unknown.

"In the foot-hills there is a bracing atmosphere with moderate elevation. The scenery is fine and there are numerous mineral springs, few of which have as yet been subjected to accurate investigation. Health resorts are being established all through this region, however."

The therapeutics of these climatic subdivisions have not yet been worked out, but some tentative conclusions can be given. Rheumatics should avoid the coast and seek the mineral spring region. In chronic bronchitis the climate of the foot-hills is followed by the best results. The coast climate acts unfavorably upon persons of a bilious temperament. Malarial cases do well on the coast. Consumptives in advanced stages of the disease should remain at home. No climate can be of permanent benefit to these. Should they go to California, the best climate for them is on the southern coast. In incipient cases the mountain belt is recommended; but consumptives should not be advised or allowed to use the mineral springs.

Mountain climbing is gaining some reputation as a therapeutic agent in this country. In Europe, Oertel is the great advocate of the method, and he has shown its great merits when applied in the proper cases. Barkan[31] says that after several weeks spent in mountain excursions the condition of the patient is radically changed for the better. There is an elasticity of the mental processes in place of the former hebetude; will, thought and impulse seem to move on wings. The formerly dull senses are sharpened. The eyes sparkle and the flabby cheeks become fuller and rosy. The prominent abdomen is reduced to more seemly dimensions, notwithstanding that food and drink are taken with greater relish, and the chest is expanded. A person who before was heavy and dull now feels as elastic and springy as if the burden of earthly existence had been lifted from his shoulders, and he goes running and skipping along, covering a distance of ten or twelve miles a

day. He is possessed of a new spirit, the pulse beats more strongly, and the entire circulatory tone is improved.

Plethora, corpulence, neurasthenia, chlorosis, incipient phthisis, and in fact most chronic circulatory and nutritive disturbances are amenable to this plan of treatment.

The physician should prescribe a regular routine at first, covering amount of walking daily, choice of food, amount and kind of drink, etc. In America the Adirondacks and White Mountains furnish the best places to put the plan in execution, because they have good roads and paths and are well supplied with hotels and lodging places. The treatment should be continued until definite results are obtained.

Setlesen[32] also writes upon Oertel's method, or "Terrain-cur." The diseases amenable to this method of treatment are divisible into two classes: First, all cases in which the heart musculature is enfeebled; in anæmia, chlorosis, the neurasthenic condition, the consequences of strumous affections, typhoid, scarlatina, diphtheria, fatty heart and corpulence. In the second class are included the diseases in which temporary improvement may be hoped for, but where the constant tendency to recur to the diseased condition exists, as in badly compensated heart lesions, derangement of the circulation in the lungs, often in consequence of traumatic curvatures of the spine, and in rachitis, strumous affections, and especially emphysema and phthisis.

Mountain Climates and Health Resorts.—From a medical point of view the characteristic mountain climates are those of the Alps and the Rocky Mountains. In a paper read before the International Medical Congress, Dr. A. Tucker Wise[33] stated that the marked peculiarities of Alpine climate are as follow:—

Dryness of the air and freedom from micro-organisms, mechanical irritants and noxious gases, low temperature, profusion of sunlight, diminished atmospheric pressure and ozoniferous atmosphere. The result on pulmonary complaints may be stated as follows:—

1. By breathing aseptic air free from dust, irritation or perhaps recurrence of infection by microbes in the respiratory tract is greatly lessened.

2. Vaporization of morbid secretions in the lungs takes place, promoted by reduced barometric pressure and dryness of the atmosphere.

3. Increased oxidation of blood and tissue from sunlight, cold air and reduced pressure.

4. Increased quantity of blood circulating in the lungs caused by the low temperature, the freedom of the circulation being aided by extended chest movements.

5. Increased activity in the pulmonary lymphatics (depending on circulation and expansion), and a general improvement in nutrition and glandular secretion; also an exhilarating effect on the nervous system.

Fisk[34] has a temperate article on conditions favorable to outdoor life in Colorado. Sunshine, dryness both of air and soil, agreeable temperature, and attractive surroundings are conditions which favor outdoor life and which are present in Colorado. The number of cloudy days, excluding night observations, at Denver for the winter of 1884–5 is given in the following table:—

CLOUDY DAYS.—WINTER, 1884–5.

MONTHS.	DENVER TIME.			
	9.08 A.M.	1.08 P.M.	5.08 P.M.	ALL DAY. 9 A.M.–5 P.M.
September	2	0	3	0
October	7	2	5	1
November	3	4	6	1
December	11	9	9	1
January	5	5	3	1
February	9	9	5	1
March	4	5	7	3
April	12	5	6	3

The hours of sunshine on the first day of January are given and compared with a number of winter stations in the Engadine with results as follow:—

	SUNRISE.	SUNSET.
Maloja	9.35 A.M.	3 45 P.M.
Wiesen	10.35 "	3.45 "
Pontresina	8.30 "	3.10 "
St. Moritz	10.00 "	3.05 "
Davos Platz	11.03 "	3.00 "
Andermatt	11.45 "	3.15 "

By way of comparison:—

Denver	7.30 "	4.37 "

The mean temperature at the three telegraphic observations of the signal service at Denver was for the winter months of 1884–5:—

	9.08 A.M.	1.08 P.M.	5.08 P.M.
September,	67.4	75.4	74.6
October,	56.2	61.1	64.1
November,	41.6	53.8	49.9
December,	25.6	32.5	26.8
January,	27.0	35.8	33.3
February,	31.9	38.0	37.8
March,	41.3	48.2	47.7
April,	47.7	53.9	54.3

The temperature due to direct insolation as compared with the temperature in the shade is shown in this table:—

MEAN TEMPERATURE.—1 P. M.

1886.	SOLAR.	AIR.	DIFFERENCE.
January,	92.5	27.3	65.2
February,	106.3	48.0	58.3
March,	107.8	41.1	66.7
April,	110.6	52.3	58.3
May,	141.3	74.3	67.0
June,	142.2	75.1	67.1
July,	146.5	85.2	61.3
August,	143.7	81.5	62.2
September,	132.3	72.0	60.3
October,	119.5	64.2	55.3
November,	100.0	41.3	58.7
December,	100.2	45.5	54.7

The following table shows the precipitation for 1886:—

PRECIPITATION, 1886.

January,	0.62	July,	0.50
February,	0.72	August,	1.62
March,	2.36	September,	0.78
April,	2.79	October,	0.33
May,	0.09	November,	1.93
June,	2.26	December,	0.87

Total . . . 14.87.

High winds (eighteen miles or over) occurred at two consecutive observations out of three the following number of times in the different months of 1886:—

HIGH WINDS, 1886.

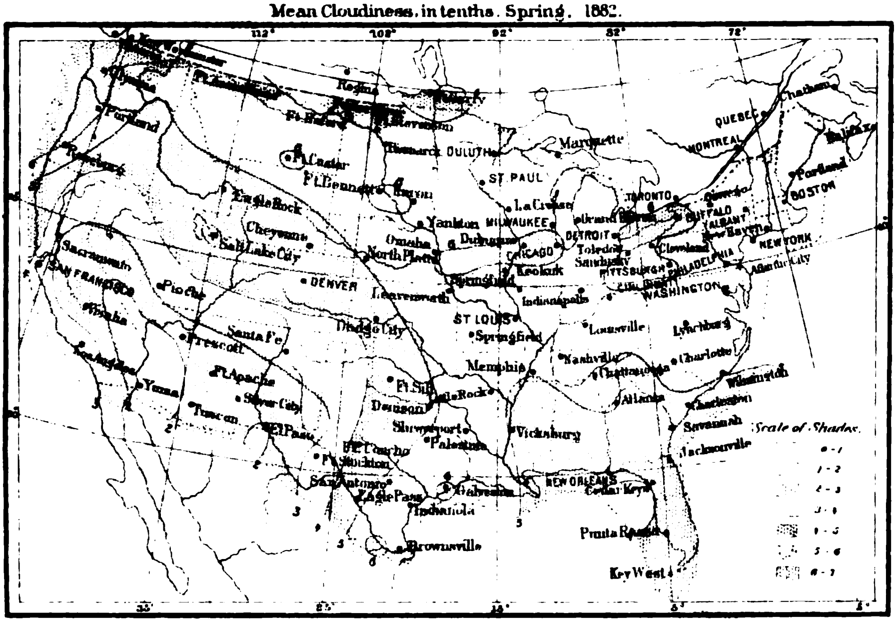
January,	1	July,	0
February,	5	August,	1
March,	1	September,	1
April,	1	October,	3
May,	2	November,	6
June,	0	December,	2

There were in addition about an equal number of times when there was a wind of eighteen miles or over at only one of three observations.

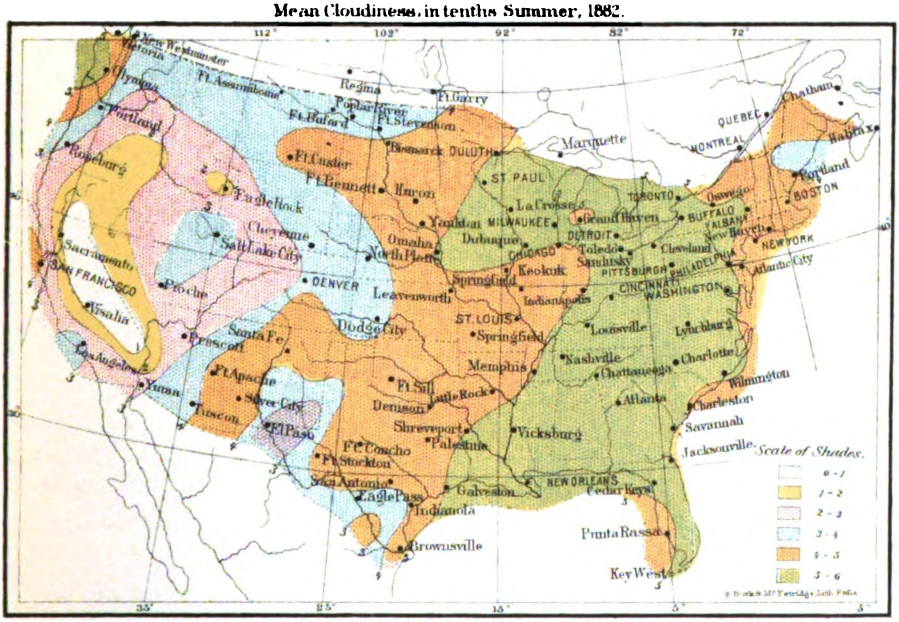
On account of the great dryness and sandy character of the soil these winds cause a good deal of dust in Denver; but in other parts of the State this objection is said not to be so pronounced.

The accompanying maps prepared under the direction of the

Mean Cloudiness, in tenths. Spring. 1882.



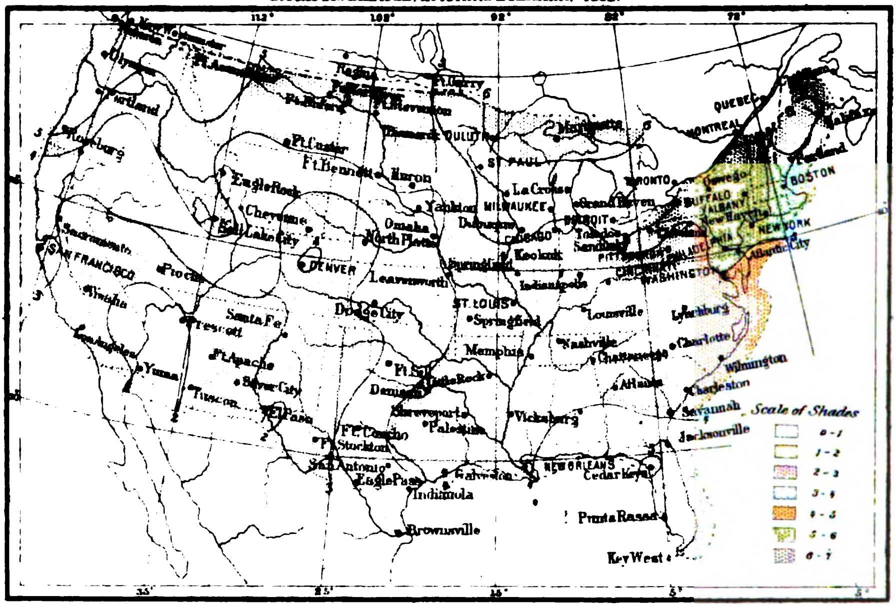
Mean Cloudiness, in tenths Summer, 1882.



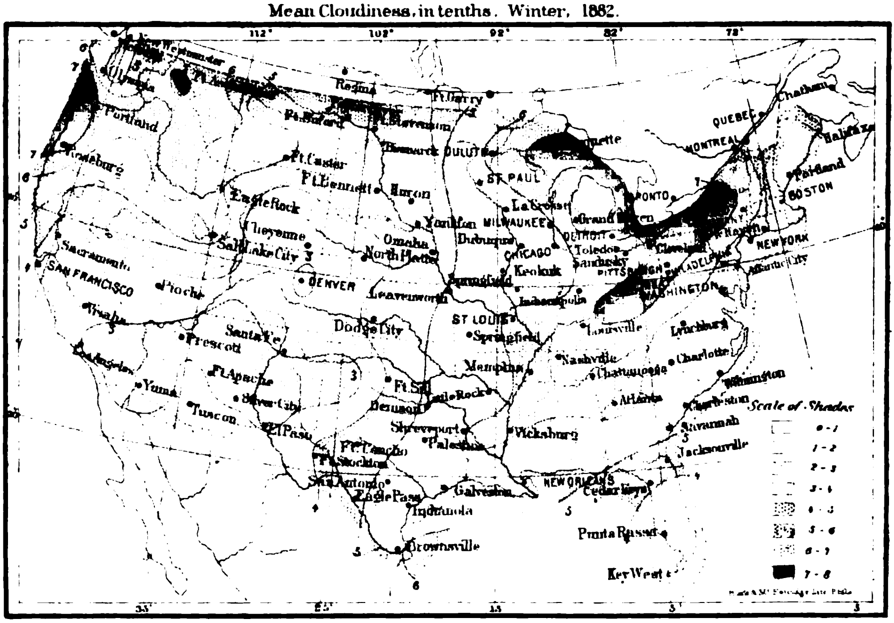
Conditions. Favorable to out of door life in Colorado (Fisk)

Boston Med & Surg Jour 9.22.87

Mean Cloudiness, in tenths Autumn, 1882.



Mean Cloudiness, in tenths. Winter, 1882.



Conditions Favorable to out of door life in Colorado

Boston Med & Surg Jour

Chief Signal Officer of the army show the comparative cloudiness throughout the country for the four seasons of 1882.

Turning to these maps it will be seen that in the spring of 1882, while the highest percentage of cloudiness in the United States was from $\frac{6}{10}-\frac{7}{10}$, in Denver it was from $\frac{4}{10}-\frac{5}{10}$, the minimum being $\frac{2}{10}$ around Yuma.

In the summer of the same year Denver was $\frac{3}{10}-\frac{4}{10}$, as against a highest $\frac{5}{10}-\frac{6}{10}$ in the East, and a lowest $\frac{1}{2}$ of $\frac{1}{10}$ in Lower and Western California. In the autumn Denver was in the portion of the country freest from clouds, the cloudiness being only $\frac{2}{10}$, and in winter it was still in the least cloudy portion, the cloudiness being only $\frac{3}{10}$.

These maps show that in the autumn and winter months Denver, which may be taken as standing for Colorado, was in the portion of the whole United States where the sky was least obscured by clouds, while in the spring it was about midway in the scale.

The advantages of Colorado Springs[35] as a resort for the consumptive are an altitude of 6000 feet, protection against strong winds, almost uninterrupted sunshine, and absence of cloudy, rainy, or foggy weather during winter. The winter sunshine is 40 per cent. greater than at Davos. The soil is porous, hence there is no mud. The invalid is not restricted to hotel life. There is nothing of a hospital character about the place with its 7000 inhabitants. Amusements are abundant. If any one desires to change his residence during the winter, there is a large number of places among which to choose. He can go to Denver or any of the towns between Colorado Springs and Pancha Springs, or if Colorado climate does not agree with him it is but a brief journey to Southern California.

Otis[36] gives some practical hints to persons going to Colorado for health. Colorado Springs offers a very suitable winter climate, while during the summer invalids should go into the mountains, where it is cooler. Dust-storms prove irritant sometimes to persons with bronchial troubles. Irritative cases and advanced cases should not be sent. Early cases are most benefited. Horseback riding is the best form of outdoor exercise. Living is rather expensive and in the mountains the food is often bad. For a summer residence Estes Park is especially suitable. Consumptives going to Colorado should go there to stay. A temporary sojourn is not advised.

Secretan[37] gives meteorological tables showing a close resemblance of the climatic peculiarities of Leysin in Switzerland to the famed winter resort Davos. There is great clearness of the sky; the mean daily sunshine is slightly in excess at Leysin. Winds are infrequent and relative humidity comparatively low. The minimum temperature is slightly higher than at Davos.

Hössli[38] recommends St. Moritz in the Engadine as a winter health resort. He says it is no colder than Davos and there is no wind in winter. Fogs do not occur. The air is pure and the sun shines 5½ hours on the shortest days. He recommends it in phthisis, chlorosis and anæmia, neurasthenia, nervous palpitation, and corpulence.

Cummins[39] writes of Albuquerque as a health resort. The altitude is 5000 feet above sea-level. The air is dry and there is much sunshine. The sanitary and social surroundings are good, the town having a good water supply, gas and electric light, good hotels and boarding houses. Sand-storms are, however, not infrequent and are unpleasant.

Schauffler[40] writes favorably of the climate of El Paso, Texas. El Paso is on the parallel of 32 degrees N., and at an elevation of 3760 feet above sea-level. The soil is sandy and porous and well-drained by the Rio Grande. The temperature in summer rises to 110 degrees F., but is mild in winter. The mean annual temperature from two years' observations is 62 degrees F. The proportion of days of sunshine is large; the amount of rainfall small, and the rainy days in the year few. Asthmatic, bronchitic, and phthisical patients seem to do well. The accommodations are fair, and the place offers advantages to those who are obliged to secure employment, as it is a rapidly growing business town.

Inland Resorts of Moderate Elevation.—In the United States the best types of this class of sanatoria are probably Aiken, S.C., and Thomasville, Georgia. Dr. W. H. Geddings read an instructive paper upon these two localities before the American Climatological Association in 1886.[41]

The paper gives original data of some value. Aiken is located in the sand-hill region of South Carolina. Its elevation above sea-level is 565 feet. It is about 125 miles from the ocean. There is a pretty free growth of long-leafed pine in the porous sandy soil. The ground water-level is on an average about 100 feet below the surface.

Thomasville is in southern Georgia, 100 miles south of Aiken, 150 miles from the ocean and 60 miles north of the Gulf of Mexico. Its elevation above sea-level is 330 feet. It is also on sandy soil, which is covered with forests of long-leafed pine and black-jack oak.

The temperature and humidity records are given in the following tables. The means for Aiken are based upon 11 years' observation, and those at Thomasville upon 4 years' records:—

	AIKEN. Degrees.	THOMASVILLE. Degrees.
November,	54	59
December,	47	53
January,	48	54
February,	50	56
March,	56	62
April,	66	67
Six colder months,	53	58
Winter,	50	55
Spring,	57	61

The average temperature at Thomasville is seen to be a little higher than at Aiken. The same difference exists in the humidity, as the following table will show:—

Monthly mean relative humidity at Aiken for seven seasons, and at Thomasville for four seasons.

	AIKEN. Per ct.	THOMASVILLE. Per. ct.
January,	62.20	65.00
February,	56 10	62.00
March,	52.10	61.00
April,	56.20	60.00
November,	61.70	67.00
December,	58.80	64.00
Mean,	57.85	63.16

The following table is of some interest as showing the comparison of mean temperatures of a number of well-known health resorts. A curious mistake is made in noting the mean temperature of Davos, which is stated to be —30 degrees. This is clearly an error, as other records show that the mean winter temperature of Davos is about 20 degrees F. above zero.

Comparing the mean temperature of Aiken with Thomasville during the six colder months (November to April, inclusive) with that of some of the larger cities of the United States.

	Deg.	Deg.		Deg.	
Aiken,	53				
Thomasville,	59				
Boston,	33	20	colder than Aiken and	26	colder than Thomasville.
New York,	36	17	" " "	23	" " "
Chicago,	34	19	" " "	25	" " "
Cincinnati,	34	19	" " "	25	" " "
Baltimore,	41	12	" " "	18	" " "
Jacksonville,	61	8	warmer " "	2	warmer " "

Comparing the mean temperature of Aiken and Thomasville during the six colder months (November to April, inclusive) with that of several well-known health resorts.

	Deg.	Deg.				Deg.			
Aiken,	53								
Thomasville,	59								
Davos,	—30	83	colder	than	Aiken,	89	colder	than	Thomasville.
Colorado Springs,	32	21	"	"	"	27	"	"	"
Denver,	36	17	"	"	"	23	"	"	"
Pau,	45	14	"	"	"	20	"	"	"
Meran,	44	9	"	"	"	15	"	"	"
Asheville,	43	8	"	"	"	14	"	"	"
Mentone,	55	2	warmer	"	"	4	"	"	"
Catania,	56	3	"	"	"	3	"	"	"
Cannes,	56	3	"	"	"	3	"	"	"
Santa Barbara,	57	4	"	"	"	2	"	"	"
Nice,	57	4	"	"	"	2	"	"	"
Algiers,	59	6	"	"	"	0	"	"	"
Cairo,	63	10	"	"	"	4	warmer	"	"
St. Augustine,	63	10	"	"	"	4	"	"	"
Madeira,	72	19	"	"	"	13	"	"	"

According to the scale of V. Vivenot, both Aiken and Thomasville must be reckoned among the moderately dry climates.

The porous and permeable character of the soil at Aiken and Thomasville allow rapid drying after rains. The winds at Aiken are probably dryer than at Thomasville on account of the greater stretch of country over which they pass. This is shown by the lower relative humidity. The winter, which is never very cold, frosts being rare, begins at Christmas and ends about the end of February.

T. Mortimer Lloyd[44] has collected information upon the climatology and climatotherapy of Asheville, N.C., and vicinity. Asheville is in western North Carolina, latitude 35 degrees, 30 minutes. Mean temperature for the year, 54 degrees Fahr.; spring, 53.70 degrees; summer, 70.66 degrees; autumn, 53.96 degrees; and winter, 38.30 degrees. In a period of eight years the maximum was 90 degrees, the minimum 1 degree F. During that time the thermometer rose above 88 degrees but twice, and fell below 3 degrees but three times.

Regarding the therapeutic effects, the replies of physicians with practical experience show that spring, summer, and autumn are the best seasons for patients. January and February are least favorable months. Prolonged residence is beneficial. Many cases of recovery are reported. Good effects were noted upon all symptoms of phthisis. Great immunity of the natives of the region. No malaria; but diarrhœa, dysentery, and typhoid have been noted.

Robison[43] gives some additional facts about Asheville, Mari-

etta, and Lookout Mountain as sanatoria. The last named is stated to be exceptionally adapted to the climatic treatment of phthisis for the following reasons: Purity of air, proper elevation above sea-level, equable temperature, no storms, abundant sunshine, opportunities for outdoor exercise, pleasing landscape, home comforts, and close proximity to a city (Chattanooga, over 30,000).

In the discussion of Robison's paper, Ross said that though any particular climate could not be said to be suitable for every case, yet for consumptive cases generally an air should be pure and dry, neither too hot nor too cold, not variable and somewhat rarefied, and should contain ozone to cause it to be invigorating. An altitude of 1000 to 3000 feet above sea-level would give this.

In Colorado he has observed that patients improve in general health, but the exudate increases rapidly and softening also progresses rapidly after it has been started. Patients with hemorrhagic tendencies should not be sent to high altitudes. (Vide Lindsay, supra.)

In San Antonio patients generally do well during December and January, but the climate is too depressing in summer.

Consumptives do not improve in Southern California all the year round. Two months in the year in Southern California and the rest of the time in the Sacramento Valley should be the best climate for a consumptive. Asheville and Lookout Mountain are good places, especially the latter. Bogue[44] endorsed Lookout Mountain with enthusiasm. During the cold of January and February a sojourn in the southern portions of Georgia and Alabama would be an agreeable change.

Luxor in Egypt, the site of the ancient Thebes, is recommended by Dr. Eyton Jones[45] as a health resort for consumptives. The maximum temperature for December, January, February, and March varied from 83 degrees F. to 110 degrees F.; the minimum from 36 degrees to 38 degrees. The daily range is frequently as much as 50 degrees between day and night temperature. The mean relative humidity is about 50 per cent. The above are winter temperatures. In summer the temperature may rise to 130 degrees and fall to 50 degrees at night. Any thing less likely to be an attractive sanatorium would perhaps be difficult to find outside of Africa.

Maritime Climates and Health Resorts.—The Southern California coast, the Atlantic coast of Florida, and the north and eastern shores of the Gulf of Mexico furnish the typical winter sea-side resorts for invalids in the United States. During the past year Southern California has been very extensively "boomed" as a health resort. The pages of medical journals, especially of the *Southern California Practitioner*, have been filled with articles descriptive of the salubrity of the climate, the magnificent natural scenery, or the enterprise of the inhabitants. The latter is especially manifest in the persistence with which the unquestionable merits of the climate in the treatment of consumption are kept before the public and professional eye. From the coast to a distance of eighty or one hundred miles inland, and from sea-level to an altitude of 3000 feet, the sanatoria are distributed. On the immediate coast, from Point Conception to San Diego, the temperature is remarkably uniform, the humidity high, the winds steady and generally from the southwest, and morning fogs prevalent. The rainfall is small in quantity and the number of sunshiny days large. Coronado Beach is the latest development of a health resort on a large scale. It is a peninsula projecting into the ocean as the southwestern boundary of San Diego Bay.

The natural climatic advantages of the place have been heightened by the most approved sanitary arrangements. Comfortable hotels, perfect drainage, electric lights, and excellent means of communication with the city of San Diego, across the bay, make it a promising sanatorium.

Fenn,[46] Lindley,[47] Widney,[48] and Curran[49] have contributed papers upon these resorts, but add little that is new. Of those places situated farther inland, Pasadena is described by Chamberlain.[50] The meteorological observations upon which the climatic deductions are based are those of Los Angeles, seven miles nearer the sea and at a considerably lower elevation. It is questionable whether they have any value as applied by the author. Sawyer[51] describes the climatic peculiarities of Riverside, which has been for some years growing in popularity as a resort for phthisical patients. Four years' observation of the temperature show a maximum of 110 degrees F. and a minimum of 31 degrees. Probably the range is somewhat greater, as self-registering instruments were not used; only the observations at 7 A.M., 12 M., and 7 P.M. being

at command. No observations of absolute or relative humidity are available; but the precipitation has been measured for six years, showing an average annual rainfall of 8.72 inches. This is unequally distributed, however. In one year there were 22.54 inches and in another only 2.94 inches. On January 12, 1882, there was a fall of 8 inches of snow. The average cloudiness is less than one-fourth.

Root[52] has lately discovered a new climatic resort in Beaumont, a settlement in the San Gorgonio Valley. It is 2500–3000 feet above the sea and eighty miles east of Los Angeles. In summer (1886) the temperature reached 102 degrees, lowest temperature 36 degrees, but the thermometer is not vouched for. The prevailing winds are light and from the west, but sometimes desiccating northers blow down in gales from the San Bernardino Mountains and absorb all the moisture. There is reason to believe that there are many unpleasant features in this Beaumont climate.

Among the coast resorts on the Atlantic side of the continent Savannah has lately found an advocate in Dr. D. F. Lincoln, of Boston.[53]

The spring, from February to May, offers many inducements to seekers after health from the North. The midwinter climate is not desirable on account of rapid changes, and the summers are too hot for comfort. Consumption furnishes a comparatively small proportion of deaths among the whites. Among the colored population the mortality from phthisis is nearly three times that from the same disease in the white race.

Concerning the climate of St. Augustine, Florida, Dr. Frank F. Smith[54] claims that the maximum temperature of the winter months is above 70 degrees F. about one-half the time. There were only three fogs during the whole winter, an average cloudiness of $\frac{4}{10}$, but twelve rains in the daytime, and "softened tonic sea-breezes which no record can estimate."

Van Bibber[55] has described the climate of Point Pinellas, on the gulf coast of Florida, which possesses many advantages as a climatic resort. The temperature is mild and equable, frosts are rare, and the soil is sandy and porous. The lack of accommodations for invalids will probably soon be rectified. In 1886 the lowest winter temperature was 23 degrees. This compares favorably with the Atlantic coast stations of Florida, where the temper-

ature fell much lower, being 17 degrees at St. Augustine and 14 degrees at Jacksonville.

J. R. Leaming[56] suggests that patients with phthisis should arrange an itinerary beginning on the northeastern sea-coast in summer and travel gradually southward as cold weather advances. In the spring the steps could be retraced in the same manner. The same plan could be followed on the Pacific coast or in the interior. State and municipal authorities are urged to establish sanatoria for those unable to avail themselves of existing advantages on account of the cost. Similar propositions are made by Goldschmidt[57] and Charteris.[58]

Dr. R. G. Curtin[59] gives histories of three cases of syphilitic disease of lungs benefited by sea voyages. Bruen[60] believed the good effects to be due to the beneficial influence of sea air on catarrhal affections of the mucous membranes especially.

J. C. Wilson[61] stated that three classes of patients should not be sent to the sea-coast; 1. Those with active febrile disturbance. 2. Those with highly excitable and nervous organization. 3. Those who have repeated attacks of blood-spitting.

De Jonge[62] recommends Palermo highly as a winter resort for consumptives. The climate is more nearly like that of Madeira than any other resort known; it is much more accessible, and has many social advantages not to be found in Funchal.

Palermo is especially indicated for those patients with chronic laryngitis, asthma, senile bronchitis, convalescence from all acute diseases, hemoptysis, established phthisis.

Neurasthenia, hysteria and other functional neuroses are benefited by a winter residence in Palermo. Syphilitics also do very well in this lovely climate.

Douglas[63] claims that Las Palmas on Grand Canary has excellent advantages as a health resort, even exceeding in point of salubrity for consumptives that "paradise upon earth," Oratava in Teneriffe. The points of advantage of Las Palmas are: 1. More sunshine. 2. Dryer air and less rainfall. 3. More invigorating climate. The Northeast trade almost constantly fans the eastern coast of Grand Canary with its dry, gentle, invigorating breeze. In Teneriffe, on the contrary, the moist Southwest counter-trade blows in winter. The mean temperature of the six coldest months is 63.1 degrees, and the daily range 10.86 degrees. Douglas con-

siders Las Palmas especially suitable to cases of phthisis of pneumonic origin, chronic bronchitis, kidney diseases, rheumatism and the infirmities of age.

Hjalmar Ohrwall[64] compares Madeira and Teneriffe as climatic resorts. He states that an equable, mild temperature and other meteorological conditions characterize both the places named.

In Teneriffe, Orotava and its environs is the best winter station; in summer the plain of Laguna is preferable. The atmosphere is extraordinarily pure and exempt from dust and miasma. There are no acute endemic maladies, no mosquitoes and no venomous animals.

In both stations the invalid may live a quiet and retired life. There are no exciting dissipations which might induce the patient to neglect hygienic precautions. On the other hand the quietude of the island reacts unfavorably upon some patients, who suffer from ennui and home-sickness.

The mean temperature of Orotava is about two degrees higher than that of Funchal, and the humidity is somewhat less. The rainfall and the number of rainy days are also less. The wind blows with more regularity. The sanitary conditions, the roads, the general comforts obtainable in hotels and boarding-houses, medical attendance, economy of living, etc., are all superior in Teneriffe. In most desirable conditions the latter resort is preferable to Madeira.

A correspondent of the Lancet points out the advantages and disadvantages of Tangier as a health resort. The winds are principally from the Atlantic, the only land-wind being from the south, and this is cooled by passing over the Atlas Mountains. It is slightly cooler than the Riviera. The thermometric record is not complete or trustworthy. Medical practitioners in the town agree that the diseases met with are mild and convalescence is rapidly established. The drainage, sewerage and water supply are bad. From the entire picture given, the place strikes one as rather to be avoided by the invalid or seeker after a comfortable health resort.

Hyères, a resort in the Riviera, is claimed to have greater advantages as a sanatorium than the other places in this region. The temperature and humidity are nearly the same as at Cannes and Mentone, but the cloudiness and rainfall are less.

Savill[65] makes some interesting communications upon the cli-

mate of Algiers and its suitability as a winter resort for consumptives. The climatic features are equability of temperature, moderate humidity (about 70 per cent. for the year) and prevailing clear weather.

An official inquiry undertaken under the authority of the French Government in 1874 disclosed the fact that consumption was only one-fifth as frequent in Algeria as in Europe. The disease rarely originates in Algiers. In the early stages when imported it is usually cured by the influence of the climate alone. When children with an inherited tendency to tuberculosis are placed under the influence of Algerian climate the disease rarely develops.

The city of Algiers offers many social advantages which render it an agreeable resort. The winter season for invalids may be considered to last from the middle of October to the middle of April.

The Crimea has been lately recommended as a health resort. Dr. F. Weber[66] gives an account of its advantages. There are four cure seasons: spring or kefir; summer or koumyss; autumn or grape; and winter.

Parsons[67] describes the climatic and sanitary conditions of Hastings and St. Leonards-on-Sea. The temperature is moderately equable, sunshiny days about four-fifths of the whole year, a chalybeate spring, good bathing facilities, excellent drainage and a low death-rate. For invalids who cannot go to Madeira or Algiers, Hastings offers many advantages in the way of climate hardly attainable at any other health resort in England.

Swain[68] calls attention to the town of Plymouth as a health resort; but a health resort with a death-rate of 27.6 per thousand and a rainfall in excess of other seaside resorts like Bournemouth, Torquay, and Brighton is hardly to be recommended in spite of the picturesque surroundings of the city.

Glengarriff and Queenstown[70] are desirable resorts for consumptives and those with asthmatic or bronchial affections. The climate is equable and mild, and at Glengarriff the scenery is magnificent.

BALNEOLOGY.

General Considerations.—In this department of practical medicine France and Germany hold a leading place in the literature for the year; but American physicians are becoming cognizant

of the vast therapeutic wealth lying concealed in the mineral waters of this country, and earnest endeavors are being made, fostered to a limited extent by the Department of the Interior of the National Government, to bring these resources to the notice of the physician and the public.

In France the mineral springs and baths are under government supervision, and authoritative analyses and inspections by State officials protect the public against incompetence and frauds in management. State governments should take similar measures in this country in order that these sources of wealth and healing power might be properly utilized. In nearly every State of the Union mineral springs exist which are not inferior in probable therapeutic power to any in the world. Mention need only be made of the famous springs of Saratoga and Sharon in New York, Bedford in Pennsylvania; the numerous sulphur, iron, alum and lithia waters in Virginia, the Hot Springs of Arkansas and Crab Orchard of Kentucky, to show the truth of this statement. Very recent analyses have shown that in arsenical waters this country is also well supplied; and hereafter physicians need not prescribe a voyage to the continent of Europe for the purpose of obtaining the curative effects of the waters of La Bourboule, Mont Dore, or St. Honoré-les-Bains, when the same effects can be obtained at home.

In order, however, that the profession and the public may avail themselves of these resources, it is necessary that a scientific and unprejudiced examination should first be made of the mineral waters of this country. This is now in hand, and Dr. Peale, of the United States Geological Survey, is engaged in the work. It is to be hoped that the results of this investigation will be placed before the public at an early day.

The most important contribution to balneological literature during the year was the issue of the fifth edition of Braun's Text book of Balneotherapeutics.[70] The completeness and critical accuracy of the work are sufficiently attested by the enthusiasm with which each new edition has been received by the German medical public. Among the more notable additions to French literature upon balneology are the eleven lectures of M. Victor Audhoui upon the natural mineral waters and thermal stations (baths and health resorts) of France. M. Audhoui[71] considers first the physical characters, temperature, odor, taste, transparency

and deposits of the waters. He divides them into the sulphurous, carbonated and ferruginous, salines, and simple thermal waters. He defines the meaning of mineral waters, their chemical constitution, their relations to the soil, their points of emergence and their therapeutical applications. In a lecture delivered at the hospital de la Pitié, Dr. Audhoui also advocates the formation of a special school of hydrology, to which he hopes that the Universal Exposi- of 1889 may contribute.

Frey[72] has investigated the effects of Turkish baths upon the circulatory organs. He found that under the influence of heat the heart's action increases in frequency and the arterial tension diminishes, while under the influence of cold the reverse takes place. On account of the dilatation of the peripheral arteries in consequence of the thermic stimulus, an unloading of the venous circulation of the internal organs takes place, and this effect is heightened by the increased loss of water by perspiration. There is therefore less demand upon the heart-muscle, and the further stimulus of the alternate application of heat and cold causes more energetic action of the heart, and thus is well calculated to correct irregularities in the circulation. Corpulent individuals with circulatory disturbances bear the hot-air bath very well; but in cases where fatty degeneration of the heart is present or cardiac insufficiency is suspected, care should be taken in the use of the cold douche. The patient must only remain in the hot bath as long as his pulse remains under 100. When it goes above, the nutrition of the heart becomes affected. Cardiac lesions are also improved under the Turkish bath; in chronic nephritis with cardiac involvement good results may be likewise expected. In emphysema Russian baths are better. The best results of Turkish baths are obtained in circulatory disturbances in which the heart is not involved.

Monard[73] has made a series of experiments to determine the physiological action of the baths of Aix-en-Savoie. His conclusions are that simple baths at all temperatures alkalinize the urine. Baths at 34 degrees C. cause considerable increase in urine voided and render the skin slightly unctuous. A douche at 34 degrees C., with massage, acidulates the urine, keeps the excretion of urea and phosphoric acid at the highest point, and diminishes considerably the uric acid. The same, with two glasses of mineral water internally, augments the urine and diminishes its acidity.

A vapor bath (42°–43° C.) for ten minutes followed by massage for ten minutes and subsequent envelopment in a sheet for ten minutes augments the urea, uric acid and phosphoric acid. The urine becomes strongly acid. The vapor bath with massage followed by twenty minutes in gentle exercise in a pool bath at 34 degrees C. instead of the sweating pack, augments the volume of the urine and diminishes its acidity.

Certes and Garringou,[74] at Luchon, and Olivier, at Cauterets,[75] found bacterial organisms in the thermal waters even at a temperature of 64 degrees C. The material known as barégin is composed of a zooglea mass mixed with sulphur particles, and the organisms are supposed to have a role in the production of this material.

Nattanson,[76] of St. Petersburg, draws the following general conclusions in regard to the therapeutical value of baths:—

Faradic baths reduce the temperature, the pulse and the respiration more rapidly and for a longer time than simple baths.

The blood-pressure is increased after cool baths of both kinds, more so, however, after the faradic, and the subsequent reduction of the pressure is slower than after simple baths.

The muscular power is increased after both kinds of baths; the increase is not so great after simple as after faradic baths.

The general condition of the patient during and after the faradic bath of different temperatures is better than when a simple bath is given.

The good effects of faradic baths are more noticeable when warm and cool water is used than with cold water.

Maricourt[77] has a somewhat inconclusive article upon the indications and contra-indications for mineral waters and sea-baths furnished by metalloscopy. He argues that the effects of mineral waters may be attributed to the metals in them, that metalloscopy will indicate the reaction of the patients to these metals, and that consequently the testing of persons by metalloscopy should precede the prescription of the internal or external use of mineral waters or sea-baths.

Riess[78] has used permanent warm-water baths in a number of chronic affections with great benefit. In spinal diseases, with a tendency to the formation of bed-sores, the method is extremely useful. Tetanus has also yielded to the constant warm bath: three cases out of five were cured. One of the fatal cases died of an

intercurrent affection after the tetanus had ceased. It is a great calmative agent and has a soporific effect in delirium and fever. In nervous diseases, such as motor and sensory paralysis, ataxia, myelitis, etc., the effects of the baths were always beneficial and in a large proportion of cases, curative.

Dropsical effusions, whether in consequence of cardiac, renal or pulmonary disease, rapidly disappeared under the influence of prolonged baths. In these cases, singularly, the urine became diminished instead of increased. In cardiac diseases, which are so generally regarded as contra-indicating the employment of baths, Riess has derived the best results, even when the valvular lesions were extensive. Chronic muscular and articular rheumatism also yielded to prolonged baths (12 hours daily) continued for several weeks. Bad results were never observed.

Valcourt[79] advocates highly sea-bathing in winter in cases of scrofula in children. He points out the disadvantages of such stations in the North, and shows that the hospital at Berck must be closed for a considerable part of the year; while in Mediterranean stations, especially Cannes, these baths can be enjoyed nearly all the year round. In 1885 the autumn was continued until December 20. The temperature of the water was 18 degrees C. in October, and gradually fell to 11.5 degrees C.,—the lowest at Cannes during the winter.

American Mineral Springs and Baths.—The waters of the Hot Springs of Arkansas are said to be useful in chronic gout and rheumatism, neuralgia, especially when depending upon gout, rheumatism, specific infection or metallic poisoning; certain cases of paralysis, locomotor ataxia, Bright's disease, diseases of the bladder and urinary organs; functional hepatic diseases, dyspepsia, chronic diarrhœa and catarrhal diseases especially; chronic squamous skin diseases, chronic alcoholism and chronic conditions resulting from specific infection. They are contra-indicated in acute inflammatory diseases, tuberculosis, organic diseases of the heart and brain, aneurism, cancer, and all diseases in which stimulation of the circulation is to be avoided.

Galvin[80] relates his personal experience at the Hot Springs of Arkansas. He suffered from inoculation syphilis and had failed to get relief from ordinary antisyphilitic treatment faithfully carried out. The method followed at the springs was bathing in water at

98 degrees F., drinking a pint of the spring-water at a temperature of 35 degrees or 40 degrees F., then going to bed until perspiration ceased. Afterward one-sixth oz. of mercurial ointment was rubbed into the back and 30 m. of a saturated solution of potassium iodide taken after meals. Spirituous and malt liquors, tobacco, fruit and pastry were forbidden. Five weeks' treatment resulted in the complete cure of a very obstinate case, which had resisted treatment ordered by a very competent syphilographer.

Hilgard has analyzed the water of Arrowhead Mineral Springs in California.[81] The temperature of the numerous springs in this locality (about six miles north of San Bernardino) varies from 140 degrees to 193 degrees F. The analysis of one of the waters is as follows:—

Temperature of water, 193 degrees F.	
Sulphate of potash, grains per gallon,	4.001
Sulphate of soda, " "	42.467
Chloride of sodium, " "	8.178
Lithium, " "	strong test
Sulphate of lime, " "	1.343
Carbonate of lime, " "	1.343
Barium, " "	a faint test
Free sulphureted hydrogen, cubic inches per gal.,	.644
Strontium,	well marked
Sulphate of magnesia,	.146
Carbonate of magnesia,	.321
Silica,	4.942
Organic matter,	trace
Total solid contents,	62.984

McCarty[82] has analyzed the waters of some mineral springs discovered on Catalina Island, Cal., and gives the following as the composition of one of them. It should make an exceedingly active saline purgative:—

In one pint:—	Grains.
Sodium chloride,	79.5
Magnesium chloride,	21.0
Magnesium sulphate,	32.5
Sodium sulphate,	20.5
Calcium sulphate,	6.0
Magnesium carbonate,	2.0
Iron and aluminum,	traces
Total solids,	161.5

Peale[83] mentions 2822 localities of mineral springs in the United States. In the North Atlantic States there are 405 localities and 637 individual springs. In the South Atlantic States there are 371 localities and 1048 individual springs. In the Southern Central States, 1201 localities and 1911 individual springs. In

the Northern Central States, 601 localities and 1276 individual springs. In the Western States and Territories, 722 localities and 3949 individual springs: making a total of 8821 springs. But a small proportion of this immense number of waters has been analyzed.

German Mineral Springs and Resorts.—Mr. Ernest Hart[84] gives in the course of a series of gossipy but very logical letters, his impressions of a Carlsbad-cure. "A Carlsbad-cure," he says, "is a very complex therapeutic agent. It is a water-cure, a rest-cure, a diet-cure, an air-cure, a music-cure, an exercise-cure, a mind-cure, and a body-cure." In other words, it is not merely the daily ingestion of so many half-pints of hot, alkaline saline water, but a combination of this with strict regulation of diet and habits of life,—conditions which are not easily obtainable at present in such perfection anywhere else in the world. Mr. Hart regards the differences of temperature and composition of the different Carlsbad waters as so trifling as to have no possible influence upon the system. He also calls pointed attention to the lack of all trustworthy objective investigation of the physiological action of the waters. He sums up his impressions in the following words:—

"What Carlsbad really affords is a highly-organized system by which it is made a matter of pleasant discipline to rise early and spend two or three hours at short intervals in gentle exercise under a pleasant climate, with a good amount of sunshine, amid surroundings which generally occupy the mind without anything which can approach excitement. It affords a well-regulated life in the open air, amidst the fir-woods; it supplies an interval of complete removal from the rush, hurry, and excitement in the course of a busy life; it provides the best of all cures for mind and body,—pleasant scenery, wholesome diet, with the universal accompaniment of beautiful music, and with these what may be properly called a natural hydropathic treatment of copious draughts, early in the day, of hot water, sipped in moderate quantities at suitable intervals of time. There are very few forms of gastric, intestinal, renal, and nervous cases which are not capable of being benefited by such a treatment even if that were not at all mineralized. It is thus that the most varied complaints and the most opposite morbid conditions are successfully treated by the Carlsbad-cure. As to the specific value of the saline constituents of the water, I profess

an absolute skepticism of the value of the minute differences which it is attempted to establish between one spout and another; but to the virtues of the Carlsbad-cure, as a whole, under the conditions and in the way in which it is carried out, after more than one experience I am a convinced convert."

Bigelow[85] writes of Carlsbad. There are 17 springs varying in temperature from 85 degrees to 166 degrees F. The principal constituents are sulphate, carbonate and chloride of sodium, carbonate of calcium and sulphate of potassium.

The diseases in which the waters are advised are corpulence (the writer's weight was reduced from 184, 1-8 lbs. to 148 lbs. in a little over two months: active exercise and restriction in diet doubtless had the largest share in this, however), passive congestion of liver, fatty liver, cirrhosis, polycholia, catarrhal jaundice, and chronic gastro-intestinal catarrh, gallstones, chronic gastric catarrh, uric acid diathesis, chronic constipation, anæmia, chronic metritis, urticaria, pemphigus, eczema, and furunculosis.

There are certain contra-indications to the use of the Carlsbad-cure. These may be summed up as follow:—

Febrile diseases, tuberculosis, cancer and other malignant degenerations, weakness from old age, aneurism and atheroma, pregnancy in feeble women, Bright's disease, and diseases of the brain and spinal cord.

The hygienic and dietetic regulations are very strict. Outdoor exercise, especially walking, is insisted upon.

The baths are lightly touched upon, but no new information is furnished.

Carlsbad itself has a population of 12,000, with a visiting population of 28,000 during the season. Average annual temperature 46 degrees F. Its altitude is 1214 above sea-level.

Gans[86] discusses the contra-indications to a Carlsbad-cure, and states that these are very few,—principally consumption and cancer. Even in the latter disease, when affecting the stomach, there may be mistakes in diagnosis; and if the disease should happen not to be cancer, the patient would have every thing to gain by a Carlsbad-cure. Youth, old age, pregnancy, congestive conditions, valvular heart-lesions, and general debility are not contra-indications, if properly managed.

Wewer[87] has written a very sensible letter against the pro-

hibition of butter as an article of diet in the Carlsbad-cure, especially in the treatment of diabetes. Suffering personally from diabetes he found that the use of butter with the waters resulted in keeping him in better condition, while the sugar disappeared from the urine as before.

Kellner[88] writes enthusiastically of the baths of Bormio in the Southern Alps. The elevation above sea-level is 4460 feet. Temperature of the waters 31 degrees R.,=102 degrees F. Composition of the waters: Total solids 1.0261 per 1000.

These constituents are:—

Chloride of sodium,	0.0112
Magnesia and alkaline sulphate,	0.3305
Sulphate of lime,	0.4863
Carbonate of lime,	0.1735

The diseases most benefited by these baths are rheumatism, paralysis, neuralgia, catarrhal diseases of the air passages and digestive organs, chronic diseases of the skin, diseases of women, and lithiasis. General depression from overwork, disease, wounds, etc., is also favorably modified by a summer residence at Bormio. The spring is early and all the seasons mild. During the warmer months the mean daily range of temperature is between 50 degrees–66 degrees F. in June and July, 57 degrees–90 degrees in August, 55 degrees–70 degrees in September. The season lasts from June to September inclusive.

Leach[89] describes some of the baths and health resorts of the Black Forest. Rippoldsau is pleasantly located, has carbonated iron waters, which are useful in anæmia, neuralgia and other nervous disorders. Chronic gastric and intestinal catarrh also yield to the waters. The season lasts from May until September.

At Wolfach is an establishment for the administration of pine-leaf baths. It is also an excellent place for fishing.

Badenweiler, at an elevation of 1400 feet, is a pleasant place for phthisical patients, convalescent and nervous cases. The baths are excellently arranged, of an agreeable temperature (79 degrees F.), and, although the waters have no specific properties, they are useful in chronic rheumatic and gouty affections.

Among the other climatic resorts in the Black Forest St. Blasien is the most attractive. The air is pure and quiet, charged with the balsamic odors of the pine, and, owing to its non-exciting character, is supposed to be especially desirable for phthisical cases

accompanied by hemoptysis. The many beautiful walks render it very well adapted for Oertel's method of treating cardiac disease and excessive corpulence by graduated muscular exercise. The facilities for social life and for medical treatment are good.

French Springs and Baths.—Boyd[90] writes interestingly and instructively of the Mineral Springs of Auvergne, describing in detail the waters of La Bourboule, Mont Dore and Chatel Guyon. The waters of La Bourboule and Mont Dore contain arsenic, the former in pretty large proportion, and are especially indicated in skin diseases. Bronchial and laryngeal affections are favorably modified by the Mont Dore waters. The springs of Chatel Guyon are aperient and diuretic, the water containing 30 grains of magnesium chloride to the gallon.

The waters of St. Honoré-les-Bains are derived from three springs varying in temperature from 22 degrees to 31 degrees C. Their combined flow is 1400 cubic feet per hour. They contain sulphur, carbonic acid, chloride of sodium and arsenic.

They are useful in bronchitic and laryngeal troubles, skin diseases, rheumatism, late syphilides, and strumous affections of children. The springs are eight hours by rail from Paris.

Odin[92] gives the following opinion of these celebrated sulpho-arsenical waters. The indications are: Skin diseases, pulmonary affections, diathesis and diseases of women. The contra-indications: Florid type of pulmonary diseases, cardiac affections and the plethoric state.

Bernard[93] writes of the treatment of diathetic states with the waters of St. Honoré. The waters of these springs favor in the highest degree the assimilative functions and regulate the secretions and excretions. Urban anæmia, impoverishment of the blood predisposing generally to disease, chronic malaria, convalescence from grave fevers, are promptly benefited by a short sojourn at St. Honoré. Rebellious choreas and recurrent anginas have been known to permanently disappear after a single season at these springs. In the mild and chronic cases of rheumatism, as well as in those extremely painful cases which so closely simulate the fulgurant pains of ataxia, practitioners have likewise obtained complete success with these waters.

In old syphilitics, with deep and incurable ulcerations, alterations of the bones, accompanied by a state of cachexia and general

wasting of the tissues which opens the way and prepares the seat of tubercle, these waters are effective.

In scrofula accompanied by intumescent or ulcerating glands, preceded or accompanied by eruptions or strumous purulent collections in caries of bones, chronic otitis and ophthalmia, white swellings, etc., "St. Honoré exercises a *curative pressure*, which may be characterized as formidable." It is above all in the diathetic diseases of childhood that these waters produce their most marked effects.

The indications for the use of the mineral waters of Eaux Bonnes[94] are especially pulmonary diseases, phthisis, asthma, chronic pleurisy and pneumonia. The elevation of the station is an efficient auxiliary in the treatment of these maladies. They are also valuable[95] in torpid anginas, catarrhal and granular rhinitis, laryngitis and bronchitis. They are also, according to Pidoux, the most effective remedy against pulmonary phthisis. The altitude of the station is an additional curative aid in this disease. In asthma, pleurisy and chronic pneumonia, also, the waters of these springs are highly useful.

The mineral waters of Chabetout[96] contain iron, arsenic, alkaline bicarbonates, chloride of sodium, manganese, lithium, silicic acid and phosphoric acid, and are especially indicated in nervous disorders.

An article on the waters of Pogues St. Léger[97] reports cases of chronic gastritis, dilatation of the stomach, with "vertigo e stomacho læso," simple ulcer, alcoholic ulcerative gastritis, cured by the use of these waters. Cancer of the stomach, cirrhosis of the liver and uterine cancer were improved and troublesome symptoms relieved.

Blanc[98] thinks that the exclusion of cardiac affections from the benefits of balneological treatment is unjustified. He has treated many cases of rheumatic cardiac diseases at Aix-les-Bains, with good results in a considerable proportion of cases.

The use of mineral waters at home is considered in a short paper by Patezon[99] on the use of the waters of Vittel in the Vosges. He regards an after-treatment of the patient at home as important. The waters of the spring should be used, and the course should follow as near as possible the regulations prescribed at the springs. A complete cure of a chronic disease can rarely be accomplished

during a short springs' season, and the after-treatment at home continues the good effect initiated at the springs.

Mineral Waters and Baths of Great Britain.—Lowe[100] states that arsenic "in minute quantities" has been found in the waters of Bath, England, and attributes to this constituent the efficacy of these waters in anæmia, nodular rheumatism and chronic skin diseases.

Smith[101] has used with good results the waters of Leamington Chalybeate Spring in that form of anæmia in young girls, described recently by Sir Andrew Clark, and which has since been termed "Fæcal anæmia."

Prof. Frankland has analyzed these waters with the following results:—[102]

ANALYSIS OF MINERAL MATTER IN SOLUTION.

Results expressed in—	Parts per 100,000.	Grains per Imperial Gallon.
Silica,	.74	.52
Oxide of iron and alumina,	.42	.29
Carbonate of lime,	12.78	8.95
Carbonate of magnesia,	.25	.17
Sulphate of potash,	1.04	.73
Sulphate of soda,	208.63	146.04
Sulphate of lime,	45.20	31.64
Sulphate of magnesia,	22.46	15.72
Chloride of calcium,	134.83	94.88
Chloride of magnesium,	64.97	45.48
Chloride of potassium,	3.27	2.29
Chloride of sodium,	628.27	439.79
Bromide of sodium,	.64	.45
Nitrate of soda,	1.22	.85
Carbonate of soda,	4.50	3.15
	1129.22	790.45

These waters are especially useful in diseases of the liver arising from sluggish portal circulation, and in the gouty diathesis for which they are recommended by Garrod.

Scarborough[103] has pure sea-air, good sea-bathing, equable temperature, healthy soil, good accommodations, favorable health record, good drainage and water supply, and chalybeate and saline springs. It has exceptional advantages as a health resort, especially for the climatic treatment of phthisis.

The Bridge of Allan, Scotland,[104] is recommended as an ideal health resort. It is sheltered by mountain ranges from violent winds and great range of temperature, and has a hydropathic establishment and a saline mineral spring, the water of which is useful in dyspepsia, habitual constipation, gout, rheumatism, affections of the liver and kidneys.

Flinn[105] writes of Irish health resorts, which he claims have been neglected for Continental and English resorts. Lucan Spa, near Dublin, has an alkaline sulphur spring, the water of which is useful in chronic rheumatism and gout, and various skin diseases.

Lisdoonvarna, in County Clare, has sulphur and chalybeate springs, and is useful in the same diseases as Lucan.

Ballinahinch has a rich sulphuro-chalybeate spring resembling the waters of Aix-la-Chapelle.

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[Undated references apply to journals published in 1887, and original articles can be found by consulting the indexes of the respective publications.]

ELECTRO-THERAPEUTICS.

By A. L. RANNEY, M.D.,

NEW YORK.

GALVANIC MEASUREMENT AND DOSAGE.

Quite an active discussion of this important subject (by no means free from unpleasant personalities and needless sarcasm) has been indulged in through the columns of various journals during the past year. Prominent among the participants in this discussion may be mentioned Drs. Rockwell, Martin, Engelmann, Massey, and Bailey.

The fact must be apparent to any one who has watched the progress of electro-therapeutics with interest that the professional mind is at last becoming keenly alive to the necessity of knowing exactly how much electricity is being administered to a patient at each sitting. The method commonly employed in the past of noting the number of cells used (even this precaution not being always taken by some writers) is only an approach to a scientific record of a case. It offers no opportunity for advancement in our efforts to bring electro-therapeutics to a tangible basis of scientific precision.

A few hints respecting the important subject of galvanic dosage may therefore be offered here with possible benefit to the reader.

Galvanic cells differ in their *electro-motive force* according to their mechanical construction, viz., the character of the elements employed, the internal resistance, etc. On the other hand, the *quantity* generated depends upon the size of the elements or the extent of their immersion, and the character of the excitant when all other conditions are practically similar.

For example, two galvanic cells of identical make and size will not generate the same quantity when one has been exhausted and the other has been freshly filled; or when one is polarized and the other is not polarized.

The electro-motive force has no relationship with the size of

the elements, but the quantity generated has. A stream may flow five miles an hour, be it a brook or a river; but the quantity of water that passes a given point in the same interval of time is not the same in each case, as the merest child can easily understand. On the other hand, a lake at a height of one hundred feet will exert no greater pressure through a pipe leading from it to the ground than would a tea-cup at the same elevation, if kept constantly filled. The quantity is determined in the first instance; the pressure (or electro-motive force) is illustrated in the latter. The bursting of water-pipes in our dwellings is not induced by the size of the distributing pipe nor by the size of the reservoir, but by the height of the original source of supply.

Again, a bullet propelled from a weapon with a given charge of powder will penetrate a board more deeply than a piece of iron. So it is with electric currents. A current of a definite electromotive force will travel faster through some tissues than others; will penetrate the skin of a thick palm with greater difficulty than the thin skin on the back of the hand; will be facilitated in its passage by large electrodes and retarded in proportion as their size is reduced; will be aided in many instances by the saturation of the electrode (especially with a saline solution), and will be retarded by the absence of such conditions; will be aided by a close approximation of the electrode to the surface of the body, and retarded by an imperfect approximation of the electrode.

Currents derived from a galvanic battery invariably enter at the positive pole (the anode) and escape at the negative pole (the cathode). Now, a bullet shot through a board tears most at its point of exit. We may consider the negative pole as that which tends chiefly to stimulate the parts with which it comes in contact or upon which its effects are indirectly exerted, while the positive pole is to be clinically regarded rather as the sedative pole, in contradistinction from the negative. The positive pole is acid in its reaction, while the negative is alkaline.

Now, when we bear the essential facts of electro-physics in mind, many of the difficulties of electric measurement are more clearly appreciated, as well as some clinical facts that are indirectly related to this subject.

To accurately determine the dose of electricity which the patient is taking, several factors have to be considered: —

In the first place, the number of milliampères (the unit of current-strength in medicine) may be measured by a reliable milliampèremeter.

This instrument must be thrown into the circuit, *i. e.*, between the positive pole of the battery and its negative pole,—the patient being similarly interposed and constituting the main resistance offered to the current which is supposed to be passing. The resistance of the rheophores and of the galvanometer itself must be added to that of the patient in determining the total of external resistance offered to the electric current,—provided that the electrodes admit of a circuit.

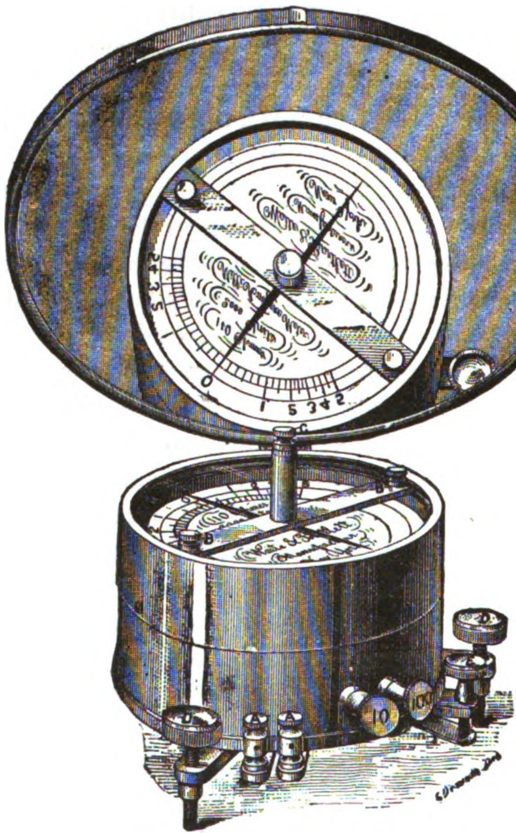
The importance of having a reliable milliampèremeter (if any is employed) must be apparent to the merest tyro in electricity. Unfortunately for science, the market is flooded to-day with cheap instruments that are absolutely worthless for scientific purposes. Many of them are never tested individually before being sold, even if made upon scientific principles. Others fail to record more than thirty or forty milliampères of current, and on that account are not adapted for use when very high currents are employed, even if deemed reliable as far as they go. Considerable ingenuity has been shown of late in the attempts of professional electricians to perfect this instrument, the utility of which is becoming more generally recognized each day, and which will soon constitute a very important part of each electrician's outfit. Perhaps one of the best instruments yet introduced to the profession is made by an American firm, and is now shown in the cut on the following page. It is known as the "dead-beat" milliampèremeter, and is manufactured by Messrs. Waite and Bartlett, of New York:—

This instrument is so called because the oscillations of its needle (which in most galvanometers amount to from fifteen to sixty before the needle comes to rest) are dampened by the suspension of the needle in a cylindrical block of copper by means of a fibre. This block becomes electrified by an induction and creates an opposing current which reduces the oscillations to three or four after the current has been shut off or reversed. By means of two shunt-coils this instrument can be made to accurately record as high as five hundred milliampères, or as low as one-tenth of one milliampère. The mirror allows the operator to read the needle-deflections with as much ease as he would those of a vertical galvanometer.

Rockwell considers this instrument a great improvement upon any other hitherto at our command for the measuring of current-strength.

The "absolute galvanometer" of Hirschmann is another desirable instrument, but it is too expensive for general use in the profession. The needle, however, rests upon two points which are liable to get bent or to oxidize.

Respecting the employment of the galvanometer in the meas-



"DEAD-BEAT" MILLIAMPEREMETER.

urement of galvanic dosage, M. Vigouroux[1] has lately contributed a paper to the Biological Society of Paris, in which he raises a point not generally considered, viz., whether the electro-motive force which propels the current through the external resistance afforded by the galvanometer, the rheophores, and the tissues of the patient should not be taken into account along with the reading

of the galvanometer. He cites, as an example, that to give two patients a current of five milliampères thirty-six Daniell elements were required in one and only twelve in the other. In both they received the same quantity; but one received it under three times the pressure of the other. In any given case, as he states, the galvanometer fails to show this point. He believes that currents are modified in their physiological attributes by the electro-motive force as well as by the quantity and density. He therefore suggests that the quantity as shown by the galvanometer and the electro-motive force, which is easily ascertainable, after noting the number and the character of the cells employed, be alike recorded in each observation. By multiplying the electro-motive force by the quantity, we obtain the energy of the current in "volt-ampères" or "Watts."

Respecting this point, this observer suggests that with an equal number of "Watts" a current of great intensity and feeble electro-motive force would have a totally different therapeutic action from a current inversely constituted.

He employs the Deprez–d'Arsonval galvanometer with a vertical needle. This instrument has one great advantage in medicine, viz., that it is perfectly astatic. He also employs a special commutator, which is so arranged as to place at will the galvanometer in the circuit of the electrode or in derivation. It is graduated for fifty volts.

The only criticism that I would make to the views of this observer is that possibly the resistance in the rheophores, the electrodes, etc., have not been uniform in all his experiments. Much of the electro-motive force may have been expended in trying to overcome an imperfect conduction outside of the tissues of the patient. In that case the patient would not receive the current under as high a pressure as the electro-motive force of the battery would indicate.

In the second place, mere measurement of current-strength by the milliampèremeter is not sufficient for exact and scientific electrical treatment of morbid physical conditions.

If an experiment be made with a fixed number of cells of the same pattern and freshly filled, by passing the current through animal-tissues with electrodes of different sizes placed upon identical spots of the same individual, it will be found that the milliampèremeter will record a larger number of milliampères when

the electrodes are large than when small, and that the smaller the electrodes the greater will be the discomfort to the patient, in spite of the fact that the amount of current is less than when the electrodes are increased in size.

Now, the *density* of the current is a very important factor in electro-therapeutics, especially so after the current has reached the diseased portion of the body which we wish to influence by it. All electrical currents tend to diffuse themselves to a greater or less extent after they enter animal-tissues; hence, if the diseased part is deeply situated there is of necessity more diffusion and less relative density than if the part be superficial, and therefore nearer to the electrode. Zenner[2] puts this point in a late lecture very clearly, when he says: "The density is in inverse proportion to the size of the conductor through which it flows; therefore, with the same current-strength it is greater when we apply small, less when we apply large electrodes. When the area of disease is near the surface we often apply small electrodes in order that as dense a current as possible should enter it; but if we wish to affect a deep-seated part, the spinal cord for example, as the current becomes very much diffused before reaching it, it is necessary that a large quantity of electricity should enter the body, and for this reason we apply large electrodes."

We have already noted the important fact that the density of the current affects the current-strength. A patient will feel a very dense current of five milliampères (administered of necessity through a somewhat small electrode) more perhaps than one of twenty milliampères entering the same region of the body through a large electrode.

In the third place, some basis of measurement of electrodes must be generally accepted by the profession before electrical dosage can be considered as placed upon a positively scientific basis.

Erb has suggested that an electrode of 10 sq. cm. be regarded as the normal size. Remak has proposed that a series of graduated electrodes of 10, 15, 20, etc., sq. cm. be employed, and the size recorded as each application is made. It has been suggested also to express the relation between the current-strength and the electrode by making the milliampères the numerator and the size of the electrode in square centimetres the denominator of a fraction.

By such a system of record the results of treatment in the

hands of different observers could be critically analyzed. Some satisfactory deductions relative to electro-therapeutics might possibly be then established beyond contradiction, provided that due care be taken relative to the saturation of the electrodes, the pressure employed upon them, the conduction of the rheophores, the skin of the patient, etc.

In the fourth place, it is very important that the placing of electrodes upon the cutaneous or mucous surfaces should be based upon scientific principles.

Erb has shown, in some diagrammatic cuts incorporated in his book, the different areas of diffusion that ensue whenever the electrodes are placed near together or wide apart. When near together the greatest density lies almost in a direct line between the electrodes, especially when applied to a similar surface of the body. When we wish to obtain the greatest possible density in deeply situated parts, or when the special effects of either pole of a galvanic battery are to be attained, the electrodes are to be widely separated.

The sternum is probably the best point upon the cutaneous surface of the body, in the vast majority of cases, for the application of the so-called "neutral electrode," *i. e.*, the pole whose effects upon the diseased part are the least to be desired. Another point commonly used for this purpose is the nape of the neck. This point is most easily reached on account of the clothing, but it is too abundantly supplied with muscles to be as desirable as the sternum.

A wide separation of the electrodes during a galvanic application is a very important point to insure in case the effects of either pole upon some special part are particularly to be desired. Thus, for example, when the electrical formulæ of individual muscles or special nerve-trunks are being tested to determine if the "reaction of degeneration" exists or is absent, the experiment should never be made when the neutral pole is sufficiently near to the active pole whose effects are being studied to influence the reactions obtained. Again, in the treatment of disease we sometimes wish to influence the diseased part exclusively by means of the anode or cathode. In such a case the poles of the battery should be as widely separated as possible.

In the fifth place, the conductivity of the skin to electrical

currents is modified by several factors which must be carefully considered in every case.

Among these the *saturation of the electrodes*, *the employment of salt in the saturating solution, and the amount of pressure exerted upon the electrode* when applied to the skin are worthy of special mention. Patients afflicted with dropsical conditions offer a less resistance than those in whom the tissues are normal.

These minor details are not to be ignored by those who endeavor to do scientific electrical work in the treatment of disease by galvanism.

If you wish to test the value of these suggestions, put a patient and also a reliable milliampèremeter into the circuit of a galvanic battery. First, use dry or metallic electrodes and note the current-strength of a definite number of cells when they are applied lightly and also firmly to the skin. Then cover the electrodes with absorbent cotton and wet them thoroughly in plain water, noting, after so doing, the results shown by the galvanometer of light and firm pressure. Finally, add a tea-spoonful of table-salt to the water and again thoroughly wet the electrodes and the skin of the patient with this saline solution, noting for the third time the current-strength obtained by a light and firm application of the electrodes. In each experiment be sure that the battery has the same number of cells in action and that polarization has not been allowed to occur. This can be insured in most batteries by raising the elements from the fluid while the cells are not in use.

The effect of firm pressure upon the electrodes and the use of salt is to lessen the resistance; hence the current-strength is often heightened by so doing. It has been wisely suggested that the handle of electrodes be furnished with a spring gauge which will enable the observer to know positively that the pressure exerted upon the electrodes in any given case is uniform at each sitting.

In the sixth place, the employment of a good rheostat in galvanic applications is very advantageous and oftentimes almost indispensable.

The conductivity of the skin varies in the same individual with the condition of the surface. When wet, as for example with perspiration, or somewhat dampened by a humid atmosphere,

it is better than when dry or parched. This tends to explain in many cases why patients feel a galvanic application of a definite number of cells more at some times than at others. The milliampèremeter will, when employed, always show the reason of this.

Again, it is often necessary for scientific record to determine the exact resistance which any part offers to the passage of a galvanic current. This can be accurately measured by a coil-rheostat. For example, the tissues of a patient may cause a deflection of the needle of a galvanometer, placed in the same circuit as the patient, of 20 milliampères with 30 freshly filled Grenet's cells. Now drop the patient from the circuit and place a coil-rheostat in his stead, adding sufficient resistance by means of shunts in the rheostat to bring the needle-deflection to exactly 20 milliampères. The resistance indicated in the rheostat marks the resistance of the tissues of the patient, the rheophores, and the electrodes, which were traversed by the galvanic circuit when the needle-deflection was first noted.

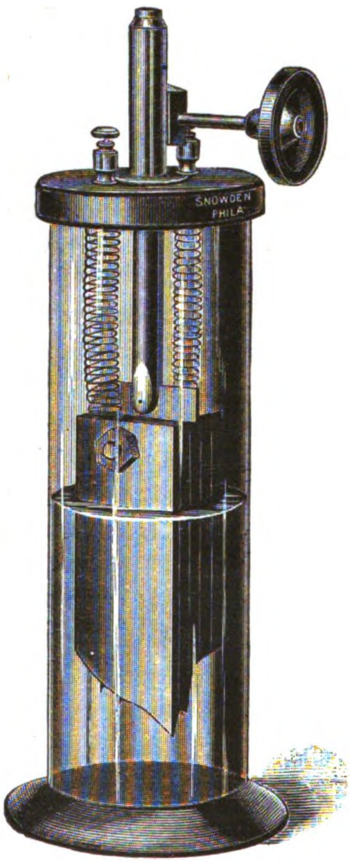
In the cabinet battery which I have devised for the use of physicians[3] I have lately incorporated a reliable coil-rheostat, which may be connected or disconnected at the will of the operator by means of a switch. This I regard as a most valuable improvement upon the original model.

The rheostat enables us, furthermore, to gradually increase or decrease the current-strength without a danger of breaking the current (an accident not without danger when very high currents are being employed). We do not have to touch the battery when this instrument is employed, but simply turn on its full capacity and graduate its strength by the rheostat alone. Many modifications of the fluid-rheostat have been made with the view of removing the many objectionable features of this instrument. I have for some years personally discarded fluid-rheostats in my practice because of the repeated annoyances they have caused and the uncertainties which attend their use.

A new fluid-rheostat has lately been devised by H. L. Bailey, which has been highly recommended by Rosebrugh,[4] of Canada, and others. I have had no personal experience with this instrument. It certainly does not accurately measure resistance (as a well-constructed coil-rheostat may be made to do), but it may

prove a valuable adjunct to an electrical outfit for practical purposes. The following cut shows the instrument referred to:—

The carbon plates of this device are made of a wedge-shape, and have pyramidal pieces of sponge placed between them. As the plates are withdrawn from the fluid in the jar these sponges hold sufficient water to afford an extremely high resistance to the passage of the current. When the plates are fully immersed the resistance afforded is extremely small. It is claimed that from ten to one million classes of resistance can be thrown into the circuit with this instrument. It is further claimed that by raising or lowering the plates of this rheostat the necessity of a commutator is dispensed with, even for the purpose of preventing a shock to the patient when the poles are applied or removed.



ROSEBRUGH'S FLUID-RHEOSTAT.
(*Canada Pract.*)

I must confess that on reading the description of this instrument I fail to see any practical advantage to be gained by its use over a well-constructed coil-rheostat. Yet, on the other hand, there is without doubt a field for a perfect fluid-rheostat. They are cheaper to construct; they are somewhat easier for a novice to manage; they can be transported with little additional weight or inconvenience; and they materially aid an operator in graduating the current without danger of suddenly breaking it while the application is being made.

A physician in general practice wants an apparatus that is light, not too bulky to transport easily, and one that is reliable under all conditions. This is the great desideratum, and unfortunately less easily furnished than desired. A reliable milliampère-meter, a serviceable fluid-rheostat, and a good galvanic battery are

perhaps the three most important parts of an electrician's outfit for general use at the homes of his patients.

The general practitioner is apt to become easily confused by a superabundance of switches, plugs, and other electrical devices. He wants his electrical outfit as simple and inexpensive as it can be made without sacrificing delicacy, reliability, and durability in any part of his apparatus. If he strives for scientific attainments he will sooner or later be able to judge himself of the defects and supply the wants with greater discretion than when he originally purchased his outfit.

At the present time gynecologists are testing very extensively the method first advocated by Apostoli for the treatment of uterine fibroids in which currents of from one hundred milliampères upward are being frequently employed.

The question of galvanic dosage has been brought prominently forward in a controversial conflict (I have explained this subject more fully elsewhere) between some of the advocates of this method and electricians during the past year, some of its adherents being accused of serious errors in the computation of the actual currents which have been employed in this therapeutic procedure.

The whole matter, to my mind, now seems to turn upon two factors which do not appear to be fully decided. These are: (1) the internal resistance of the batteries employed to generate the current; and (2) the external resistance which the rheophores, the galvanometer, and the animal-tissues traversed by the circuit together help to constitute.

Now, the employment of a coil-rheostat will enable any one to determine the exact resistance offered by the tissues in each individual case with little loss of time or labor.

The external resistance to the passage of a galvanic circuit is a very important factor in modifying the current-strength which the milliampèremeter indicates. There are only three factors in Ohm's law, any one of which can be easily figured when the other two are known. Ohm's law is as follows: The *electro-motive force divided by the resistance equals the current-strength.* The electro-motive force (E) is estimated in *volts;* the resistance (R) in *ohms;* and the current (C) in *ampères.* To put this in a mathematical form, the following equations are applicable to the solution of any such problem:—

$$C = \frac{E}{R} \text{ or } E = C \times R \text{ or } R = \frac{E}{C}$$

Finally, in the seventh place, the length of the sitting is a factor in electrical dosage.

This factor must unfortunately remain, for some time at least, a matter of pure empiricism. As a general rule, the weaker the current the longer may its application be prolonged. Still there are, without question, certain individuals who are more tolerant of electrical currents than others; and the physical conditions of each patient have to be taken into consideration before the duration of a *séance* can be decided upon. Of necessity, the experience and judgment of the operator will always prove of material service in deciding such questions as they arise; and it is here that the success of some and the lack of success of others may possibly lie.

The tendency of the age is toward the use of much stronger currents than were formerly considered judicious by the German investigators. Especially is this true in the treatment of some of the graver diseases, and in the many conditions where electrolysis and the galvano-cautery are now successfully employed.

In concluding my remarks concerning galvanic dosage I trust the many aspects of the question may now be more clearly understood by some of my readers; and that the necessity of a more complete electrical outfit than many general practitioners now possess may be apparent to them. These remarks apply only to galvanic currents, and not to faradaic or static applications.

ELECTRO-THERAPEUTICS.

Destruction of the Fœtus in Extra-uterine Pregnancy.—The testimony respecting the efficacy of galvanic currents, as well as of faradaic applications with strong coils, in destroying the life of a fœtus in extra-uterine gestation seems constantly to be on the increase. Galvano-puncture has also been successfully employed during the past year by Petch of the York Infirmary. The passage of strong galvanic shocks through the mass (Rockwell) or the tetanizing of the fœtus by powerful faradaic currents concentrated between one pole in the vagina and one on the abdomen over the tumor for an interval of an hour (Blackwell) will generally result in the death of the fœtus without danger to the mother. The employment of stabile applications of galvanic

currents at intervals of two or three days, during several weeks subsequent to the destruction of the fœtus, will materially aid in the dissipation of the tumor. The electrodes are placed so as to include the mass betwen them, the negative pole (cathode) being preferably placed in the vagina.

The method employed by Rockwell is seldom continued for over ten minutes at a sitting, and the current is frequently interrupted so as to give a shock. Three sittings within four days were reported in the last successful case of that author.[7] The current-strength was not apparently measured, but twenty cells were employed, presumably those of Grenet, freshly filled. A metal ball-electrode (the cathode) was used in the vagina posteriorly to the cervix, and a flat-sponge electrode (the anode) was placed on the abdomen over the tumor.

The method advocated by Blackwell[8] is designed to obviate the danger of rupture of the sac, which may arise from prolonging the treatment over a week or more before the death of the fœtus is insured. On the other hand, Aveling reports a successful case treated by faradaic currents sent directly through the mass for four consecutive days, for ten minutes at a sitting. The patient had reached the third month of gestation, and the strength of the current employed was a comparatively mild one, except for the last thirty seconds of each sitting.

Electrical Treatment of Insomnia.—The relief of this distressing symptom has long been a subject of investigation. Dr. G. B. Massey discusses in a late contribution[9] the effects of four methods of treatment of insomnia by electrical currents.

The *first* of these is the method of Weir Mitchell, viz., the employment of faradaic currents to individual groups of muscles, one after the other, excepting those of the face and neck, until the most accessible groups have been stimulated to contract seven or eight times each. The vibrator should break the current about eighty times per minute, and medium or large electrodes should be employed. Such an application is thought to be particularly of service in poorly-nourished patients who suffer from cold extremities and other evidences of imperfect circulation.

The *second method* is the employment of static insulation, and the passage of a "ball-electrode" over the entire body and limbs, sufficiently near the patient to draw small sparks. In the expe-

rience of the writer, the wooden ball or carbon electrode covered with velvet is preferable for this purpose to one of metal, provided the machine employed is one of large generating power. The experience of Dr. Massey coincides with my own in the view that this system of treatment is fully as refreshing as the "general faradization method of Beard and Rockwell, and it has the great advantage that it is employed without the need of disrobing, and the other unpleasant accessories of that method.

The *third method* is the application of the anode of a galvanic battery to the occiput and the cathode to the back. The electrodes should be thoroughly saturated in a solution of salt, and the current gradually increased in strength during the sitting, and again decreased to a low point at its termination. Dr. Massey uses a rheostat for the purpose of modifying the current-strength, which should not exceed five milliampères. The *séance* should not exceed ten minutes.

The *fourth method* advocated consists of faradization of the occiput, with the other pole widely separated. I hardly understand why the author referred to speaks of the use of either pole in this connection (he advocates the positive) with special reference to its therapeutical action, since all faradaic currents are alternating.

The conclusions of this observer are as follow:—

The first method is not directly hypnotic. It only induces sleep indirectly because of the necessity for an increase of blood created by the muscular contractions. The determination of blood is thus directed toward the periphery of the body.

The second method is, according to this observer, to be also classed as an indirect hypnotic, and its action is attributed by him to the effect made upon the peripheral sensory apparatus. In my experience the motor contractions which follow applications of the indirect spark are not to be ignored. Whenever the metal-ball electrode is employed these are often extremely violent.

To the third and fourth methods the observer quoted attributes a decidedly sedative action upon the brain. He states that two milliampères are not to be exceeded as a rule when the third method is employed. In the fourth method he lays stress upon the regularity of the vibrations of the interrupter.

To the views expressed by Dr. Massey I would add that the static induced current is in my opinion worthy of a trial in place

of the fourth method described by him. It can be administered without any inconvenience to the patient, is less painful than faradization with widely separated poles, and is fully as effectual in my experience. The interruptions are absolutely constant, because they depend upon the separation of the poles of the machine. The current also has a distinct polarity which the faradaic current has not. I have described this method very fully in my late brochure upon static eletricity.[10]

Treatment of Rectal and Urethral Stricture by Galvanism.—The success which has been attained in the treatment of urethral stricture by electrolysis has stimulated the profession to a trial of this agent in the rectum. Blackwell reports the observations of Whitmore, who lately read a paper on this subject before the West London Medico-Chirurgical Society. This observer had admirable results in relieving several cases of rectal stricture which had been more or less intractable to the ordinary methods of treatment by dilatation, particularly so in one case where dilatation had been carried on for two years and where the symptoms were alarming.

The treatment of this case extended over a period of three months and resulted in a radical cure. The details of the method of procedure were not stated; but it is safe to presume that the principles of treatment by electrolysis can hardly differ greatly in their application when used in the rectum from that commonly employed in the urethra and other musculo-membranous canals.

In the urethra the difficulties encountered are chiefly (1) that of insuring a passage of the instruments along the normal canal as the constriction yields to the influence of the current, and (2) the concentration of the current to the constricted portion of the canal. The apparatus devised and employed by Robert Newman, of New York, for this purpose can hardly be improved upon. Any of the ordinary tunnelled instruments which slide over a whalebone guide can, however, be insulated (omitting the extreme point) by thoroughly shellacing them, and thus be employed as an urethral electrode for this purpose in case of need. The pole of the battery not employed upon the urethra can be attached to a large sponge-electrode and placed upon the thigh, perineum, abdomen, or other adjacent skin. It is probably unnecessary to state the general principle so often repeated that when chemical effects are desired (as in

electrolysis) galvanic currents are alone of service. Faradaic or static currents are of no use for such operations.

Electrical Treatment of Jaundice and Torpidity of the Liver.—There is little doubt to my mind that electrical applications can act as a colagogue, and materially increase the secretion of the liver. It is with pleasure that I note a confirmation of this view, which has been recognized by me for some years. The two currents which seem to exert the most marked action upon the liver are the faradaic and the static.

For some years past I have been in the habit of using the indirect static spark[11] over the liver for the relief of an apparent lack of secretion of bile. Blackwell[12] lately adds his confirmation of this view. He also cites the statement of Secretan made before the Geneva Medical Society that the cure of a child suffering from an intractable form of catarrhal jaundice, which had resisted all form of medicinal aid, had followed three applications of faradaic currents of ten minutes each, one pole being in the rectum and one over the site of the gall-bladder.

Prior to my employment of static electricity it was my custom to use this method of treatment selected by Secretan very extensively in treating patients who suffered from habitual constipation. In many cases the passage of strong faradaic currents through the different axial lines of the liver (recommended highly by Blackwell) will prove of equal benefit, provided the ducts are not occluded.

Galvanic Treatment of Nocturnal Incontinence of Children and Relaxed Sphincters of Adults.—The beneficial effects of galvanic applications made locally in these distressing conditions have been discussed by Steavenson in a late contribution.[13]

Galvanic Treatment of Chronic Ulcers.—The employment of galvanic currents of a strength varying from ten to fifteen milliampères to chronic ulcerations seems to have led to happy results in the experience of several observers during the past year. Meyer,[14] of Berlin, reports the cure of a badly ulcerated tongue which had resisted treatment for nine years. It required one hundred and ninety applications. Blackwood[15] also reports the cure of a chronic and intractable ulcer of the leg by ten similar applications.

Induction of Premature Labor by Electricity and Electrical Applications during Labor.—This subject is one of great interest

to the general practitioner. In a review of this subject by Blackwood[16] the results obtained by Walcher, Baird, Bayer, and himself are discussed. The points upon which the experiences of these gentlemen shed light are (1) that premature labor may be induced by galvanism, but preferably so by faradism; (2) that the fœtal head need not be excluded from the direct path of the current, because the child will bear all that the mother can endure, and also probably because the electrical current passes around the child rather than through it by following the tissues of the womb, that offer a better path of conduction; (3) that, in inducing premature labor by galvanism, the anode should be at the fundus and the cathode in the cervical canal; (4) that a normal labor is greatly aided by applications of the faradaic current. According to Baird, faradaic applications tend to modify the pains, to assist in dilating the os, in intensifying the uterine contractions, and in strengthening the abdominal muscles. They also tend to shorten the duration of labor, to prevent post-partum hemorrhages by insuring firm uterine contraction, and to save the vital forces of the mother, thus aiding in a rapid convalescence.

THE GALVANO-CAUTERY.

Among the many uses to which this admirable form of cautery may be put new ones are being reported constantly. Some original observations have been lately made in this direction:—

Dumesnil, of Rouen, and Genzmer, of Halle, have employed this agent in the *treatment of scrofulous glands* of the neck with marked benefit. A platinum wire is introduced and then heated without any attempt at anæsthesia. The gland may suppurate or be resolved without suppuration after such a procedure. The scar induced is an insignificant one.

Concerning this step it may be pertinently suggested that the destruction of all caseous deposits is a desirable prophylactic measure in scrofulous subjects, irrespective of the cosmetic effect of their removal when situated about the head and neck.

De Haviland Hall reports a series of cases[17] where the galvano-cautery was employed in the nose with relief to hay-fever, asthma, rose-cold, and uncontrollable sneezing.

Genzmer, of Halle, reports to the Sixteenth Congress of German Surgeons the success of the *treatment of scrofulous glands*

and tuberculosis of the testicle by the electro-cautery. In the case of glandular enlargements repeated punctures were made in all directions. This caused their total disappearance in a few weeks. In tuberculosis of the testicle (five cases) he was forced to employ this method by the refusal of the patients to submit to castration. Two of these recovered completely, and in the remaining three cases the size of the testicle was greatly reduced.

The same observer reports *three incisions into a goitre*, which was causing suffocation, by a galvano-cautery knife. The incisions were three centimetres deep, and the blade was left in the wound at each incision for some seconds. The result was very markedly beneficial.

In the treatment of *hypertrophied tonsils* the galvano-cautery is certainly destined in my opinion to supercede the old method of excision. The danger of hemorrhage in these operations is not one to be sneered at. Whenever it does occur (and it is liable to happen sooner or later with the most skillful operator) it is a most serious and alarming accident. The success obtained by the employment of the electrical cautery in the treatment of this condition is certainly very gratifying to all who have employed it. Several punctures or incisions may be made at one sitting without pain, after a free application of cocaine to the part.

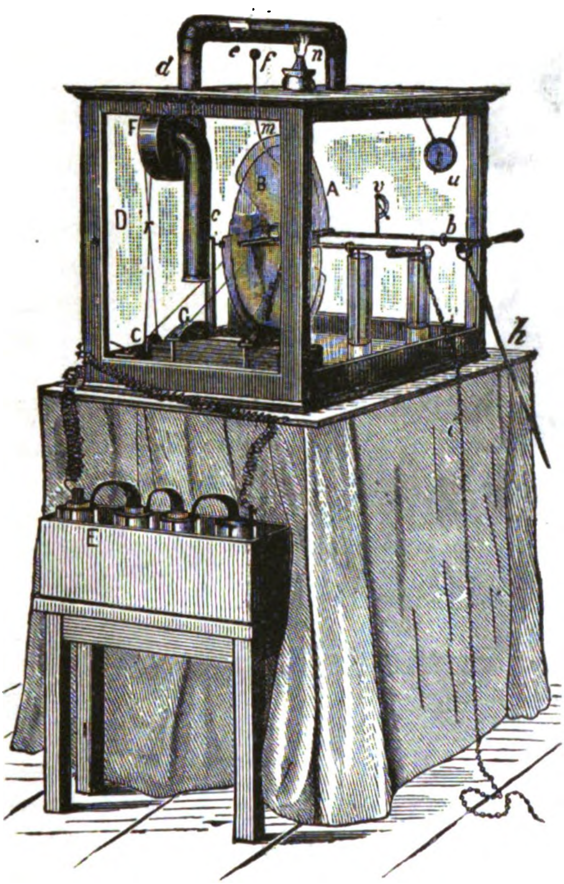
STATIC ELECTRICITY.

Mechanical Devices.—An improvement in the case of a static machine has lately been introduced by Queen & Co., of Philadelphia, which recalls very vividly to my mind some experiments of my own when engaged in perfecting my improved model of the Holtz induction machine. It consists of a device for the heating of the air within the case for the purpose of drying the plates and depriving them of all moisture. The opposite cut will make this device intelligible to the reader.

It will be seen that a metal tube is attached to the case with both ends projecting into its interior. Above the top of the case, the air in the tube may be heated by means of an alcohol lamp, and the circulation through the tube is accelerated by the introduction of a fly-wheel with fans which revolves in a drum. This fly-wheel is run by an electro-motor propelled by four Bunsen's cells outside of the case. Its revolution insures the constant inter-

change of hot air for the cold air as it is propelled over the heated portion of the tube.

Theoretically this is a most valuable attachment to a static machine; but I fear the inventor has attained little that I did not long ago abandon. I found in my experiments made several years since with a somewhat similar attachment that the mechani-

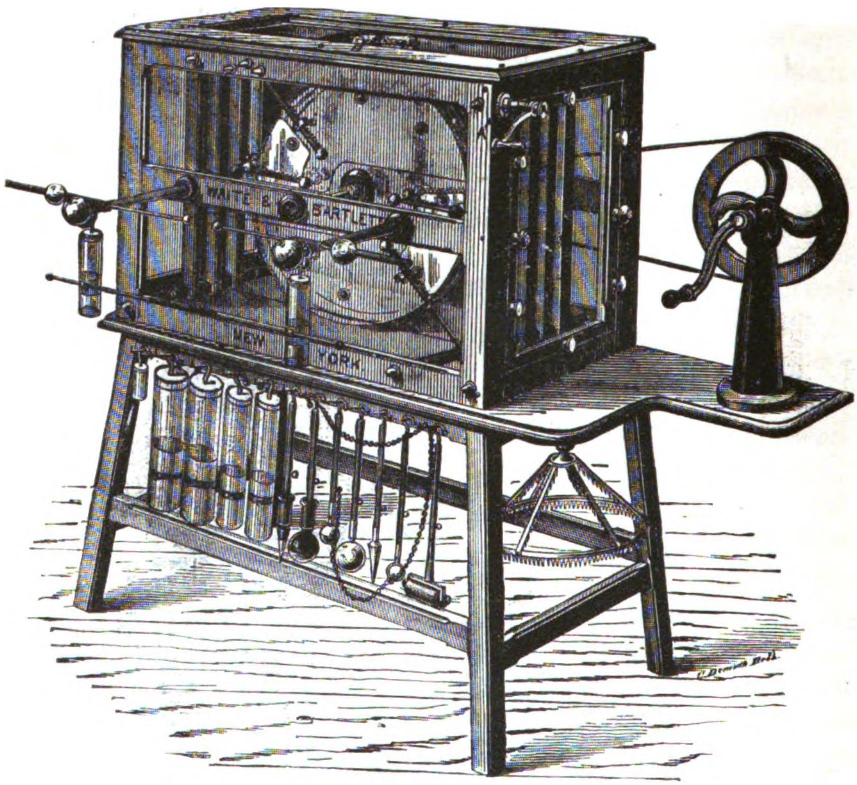


IMPROVED STATIC MACHINE.

cal difficulties in keeping the case absolutely air-tight when any such attachment was added to it were practically insuperable. The perforations of the case rendered necessary for the metal tube must admit of its expansion and contraction when subjected to varying degrees of temperature. These openings could not be hermetically sealed against the entrance of air from the outside

without adding greatly to the cost of the instrument. I therefore came to the conclusion that a poor device was worse than none, and directed my energies to a hermetically sealed case, which up to this time has apparently given perfect satisfaction. I insured this end by packing all the joints of the wooden case and all apertures through the glass by means of felt and rubber.[15]

The cut of my own model (which I now insert) was lately



RANNEY'S STATIC MACHINE.

presented for the second time to the profession by Blackwood—unfortunately without any recognition of the many months of time which I devoted to the minor details of its construction. It is now manufactured by Waite & Bartlett, 143 East 23d Street, New York City.

THE PRINCIPLES OF STATIC INDUCTION.

So little has been written concerning statical electricity as a therapeutical agent that I feel justified in devoting more space to

this subject than I otherwise would. The profession both here and in Europe are rapidly becoming awakened to the fact that we possess in statical electricity an invaluable and too-long-neglected aid in the treatment of disease.

Any body when electrified has the power, to a greater or less extent, of exerting (even through an intervening substance, which in this instance consists of a plate of glass) a peculiar effect upon the electrical state of another body closely adjacent to it in position. It tends to draw from the opposed body that variety of electricity which it does not itself possess. Now, if an intervening substance happens to exist between the two bodies the electricity drawn toward it by induction may be deposited upon the corresponding side of that substance, and a proportionate amount of electricity of the opposite variety is abstracted from the intervening body. Hence, the intervening body becomes either positively or negatively electrified on one side, as the case may be.

In the induction machine the intervening substance happens to be the revolving glass plate, and the opposed bodies are the two paper collectors and the two metal combs of the machine, which are separated by the revolving plate of glass.

In all induction machines the charge is *practically constant when once established*, provided the mechanism be perfect and the plates kept absolutely dry. Under such conditions it ought never to fail to produce its full effects when the wheels are set in revolution. This is a great desideratum in medicine.

In the original Holtz model only one stationary and one revolving plate were used. Both were circular in shape. The stationary plate had openings or "windows" cut in it. Paper collectors were glued to the stationary plate, so made as to project from it and to come in close contact with and to face the openings in the stationary glass plate. The revolving plate was insulated by legs of glass, while the stationary plate was not. Metal combs were used as terminal attachments to the inner end of the two poles of the machine. They faced the revolving plate and almost touched it.

You will find all these mechanical features practically preserved in the improved models of to-day. The revolving and stationary plates have been increased in number, simply to augment the quantity of electricity generated. The stationary plates are no

longer circular; they are made in two pieces, to allow of "windows." Two paper collectors are glued to each stationary plate. These terminate in points which project into the "windows" made by dividing the plates. The poles of the machine have metal combs on one end, and a brass ball at the other. Extra combs have been added to draw off residual electricity which accumulates in excess; but these are "grounded."

Furthermore, the machine has been encased, simply to protect it from atmospheric changes. Cat-skin rubbers have been added. They are of use only as a means of exciting the plates when from any cause induction shall have ceased. We call them the "chargers" of the machine.

There have been many mechanical modifications made from time to time of the original model which have not been here specified by me; but as they do not in any way affect the principle of electrical induction, they are not of importance in this connection.

In the original Holtz machine a charge was primarily effected by rubbing a piece of ebonite briskly with cat-skin until it became highly charged with negative electricity, and then applying it closely to one of the paper collectors on the stationary plate of the machine. By the "law of induction" the comb opposed to this paper collector becomes electrically excited immediately. It at once deposits *positive electricity* on the side of the revolving plate nearest to the comb, and takes *negative electricity* away from the revolving plate. Thus the revolving plate becomes *positively electrified* to a very high degree at this point.

Now when the wheel is made to revolve to that point where it meets the other paper collector upon the stationary plate, induction again takes place. Negative electricity is deposited (1) by the collector on the opposite side of the revolving plate (the side nearest to the paper collector) and (2) by the metal comb; at the same time positive electricity is taken from the adjacent side of the revolving plate by the collector, and also by the metal comb from the opposite side of the revolving plate. This interchange of electricities charges the "positive pole" of the machine.

The revolving plate (now excessively charged with *negative electricity*) goes on to the next paper collector. Here a similar exchange of electrical conditions occurs. The negative electricity

is taken from the revolving plate by both the paper collector and the metal comb, and positive electricity is given to the plate in exchange from both of these sources. Hence the "negative pole" becomes highly charged.

As long as the revolving wheels are kept in revolution this interchange of electricities continues at each of the poles. Hence the accumulation at each pole soon becomes sufficiently great to allow of an escape from pole to pole in the form of a spark, or into the atmosphere as a "luminous brush" easily seen in the dark.

Static Electricity as Compared with Galvanism.—It has been computed that the *electro-motive force* of a Holtz induction machine is 52,000 times as great as that of a Daniell cell (or 52,000 volts). It is not affected by the velocity of rotation.

The *quantity* generated is proportionate to the velocity of rotation and the number of wheels employed. On this account I have lately increased the size of the driving-wheel, so as to insure rapid revolution of the plates of the machine. It is modified also by the moisture present in the atmosphere.

The *internal resistance* of the machine diminishes rapidly with increased velocity of rotation. It is not influenced by atmospheric conditions.

STATIC ELECTRICITY IN MEDICINE.

The revival of static electricity (or Franklinism) as a therapeutical agent from the oblivion into which for nearly half a century it had unaccountably sunk has been occasioned by several factors. Among these factors the following may be prominently mentioned:—

1. The awakening of the profession at large to the fact that *electrical currents of different kinds have distinct therapeutical actions.*

These are not to be attributed to or confounded with the strength of the current employed, or its method of application. The effects of faradization, galvanization, and franklinization upon animal structures differ widely in many respects. The time has come when an intelligent physician cannot justly condemn all forms of electrical treatment of any individual case because he has failed to obtain satisfactory results with one of the above-mentioned currents alone,—even if he has employed that particular form of current with the highest possible skill and judgment.

This is an error into which many are unwittingly led. I

could report, if space would permit me to do so, the details of several cases where a failure to employ the proper current has proved most disastrous to patients. One instance of this character, which was happily aborted, impressed me so forcibly at the time that it is possibly worth narrating:—

A patient who had accidentally severed the musculo-spiral nerve by a pistol-bullet was sent to me some years since for diagnosis, and to confirm or reject an opinion which had been expressed by a physician of prominence, namely, that the only hope of cure lay in a surgical operation for the uniting of the severed ends of the nerve by sutures. This opinion, as I found, was based upon the fact that the *faradaic current* had failed to produce any movement in the paralyzed muscles; and that several months had already elapsed since the accident, during which time the hand was steadily becoming more and more deformed by contracture of the flexor muscles of the hand and forearm.

My examination of the patient showed, however, that a *galvanic current* produced violent contractions of the paralyzed muscles when *passed through the injured nerve*, one pole being placed upon the sternum as a neutral point, and the other upon the musculo-spiral nerve; and the galvanic reactions of the nerve and its muscles furthermore indicated marked "degeneration" as having developed in the nerve below the point where it had been divided. Thus the question of the advisability of an operation was decided positively in the negative. The nerve had already united.

In about eight months the injured nerve was completely restored by the use of the "static spark," the contracture had disappeared, and to-day the patient can see no difference in the usefulness of his hands.

2. The *improvements which have been made in machines for the generation of static currents* for medical purposes have had much to do with the revival of this method of treatment.

Some of the cases reported in the earlier encyclopædias and antiquated works on electricity are fully as startling as those now encountered when treated with the improved machines; but, on the other hand, many failures to obtain good results must of necessity have occurred in olden times from the imperfect apparatus depicted in the scientific works referred to. I have

already referred to some improvements which have been made from time to time since Holtz first devised the present model of an induction machine (1865).

3. *Improved methods of administration* of static currents have added materially to the effectiveness of this agent as a cure of disease. Some of these methods were unknown in earlier times (as far as my research goes to show).

4. It is now known that a *considerable quantity*, as well as *length of spark*, is essential to the successful use of a static machine in medicine. Many of the static machines sold to-day are practically worthless save as a toy, because they do not produce a sufficient quantity of electricity. The requisites of a static machine for medical purposes will be touched upon later.

5. Experimentation with this agent seems to have confirmed the views of its enthusiastic advocates of the present day, and to support the accuracy of many of the observations reported in old scientific works. The incredulity of the past is rapidly being overthrown in respect to this method of treatment; and the special fields in which it proves of the greatest service are being definitely mapped out by those who are scientifically recording the results of its administration.

For the past few years I have devoted considerable attention to the improvement of the Holtz induction machine. Some of the results of my experimentation have already been published. The machine now described to you is in some respects an improvement upon the one which I originally introduced to the profession through the *Medical Record* of October 17, 1885. I have modified the charger originally used by me, so that it now bears upon the *outer revolving plates above the metal combs*, instead of passing between the central revolving plates. I have found that the application of cat-skin at this point on the outer plates awakens the machine into action (when not charged) with greater rapidity and certainty than at any other part of the machine. Furthermore, there is no longer any difficulty in making the contact between the charger and the glass when the wheels are revolving rapidly.

A *slight touch* of the charger of short duration upon revolving wheels, repeated at intervals of a second or two, is more effective than a long-continued application to the wheels of an induction machine.

With the old charger the springing of the rubbers often rendered their insertion between the revolving plates (which are in extremely close approximation) a matter of some little annoyance at times. This modification in the charger has entailed a slight change in the mechanism by which the rubbers are brought into play when needed. In some models of the present day the charger cannot be raised from between the revolving plates. This is a serious defect.

Again, although chloride of calcium is not required during the cool months in this particular machine for the purpose of drying the air contained within the case (on account of the rubber-packing between all the joints of the case, which almost hermetically seals it), I have found it desirable to use this or some other means of artificially drying the plates *during the summer months*, because the air is then excessively laden with moisture. To allow of the introduction of a tray containing chloride of calcium without opening the doors of the case, I have been forced to modify the wood-work of the machine somewhat, and I have also raised the lower level of the stationary glass plates about two inches. By this means I can now slide a tray of nearly the whole width of the case underneath the plates, and thus expose the air within the case to a large absorbing surface which deprives it of moisture very rapidly.

I hope in time to so perfect my system of packing the joints and the openings in the case (entailed by the parts of the machine which must of necessity perforate it) as to make it absolutely air-tight at all seasons of the year. When this feat is accomplished the necessity of chloride of calcium or any artificial dryer within the case will have been entirely dispensed with. In several instances I have known the *chloride of lime* sold in commerce to be placed within the case of a static machine. The result has been to almost ruin the metal parts of the machine. It took a mechanic nearly a week in one instance to restore the effectiveness of the instrument. Until cabinet-makers can be found who never make mistakes, or a better material than highly finished and shellaced wood can be obtained from which to construct the framework of the machine, I fear this scheme will never be perfectly accomplished. It has been computed that fifty coats of shellac-varnish are requisite to prevent the penetration of gases through

stone. Practically, however, this necessity is not so great as it might at first seem; because during the summer months the diffusion of static electricity into the atmosphere is so great as to seriously interfere with a satisfactory application of this agent to a patient by the methods known as "insulation," the "indirect spark," and the "static wind," in spite of a perfect generator. These methods, as well as other forms of application of static electricity, will be described later.

In other respects than those enumerated the modified Holtz induction machine introduced to the profession by myself some time since remains practically unaltered. Its effectiveness seems to have been preëminently satisfactory to those who have used it, and the quantity and length of spark which can be elicited is as nearly an approach to the maximum of its theoretical quantity and power as could be hoped for.

No static machine can give off a spark greater than the radius of the revolving plates. I have frequently produced from my own model a spark of eleven and a half inches from a wheel of twelve-inch radius. Furthermore, I think I can justly claim to have so improved all previous models built on the original Holtz plan as to insure a continuance of the charge throughout nine months of the year without recourse to artificial means for drying the plates. When properly cared for and handled there is little necessity even for a charger during these months.

Before I pass to the consideration of static electricity as a therapeutical agent, it may be well for me to state that the cost of a static induction machine with plates of twenty inches diameter or over must of necessity be large, although the cost has been materially reduced of late by competition and improved methods of manufacture.

Again, it is impossible to transport a static induction machine from house to house without danger of breakage and the employment of a cartman; hence it becomes a part of a physician's office-outfit only, and cannot be used in medical practice except by bringing the patient to the machine or going to some expense and risk in transporting it.

Finally, a static machine of the induction model requires a certain amount of care; otherwise the effectiveness of the instrument is liable to deteriorate and its component parts to become more or less injured.

There is another form of static machine (already described as the Toepler model) which has been sold extensively to the profession. It has no case to protect it from the atmosphere. It can therefore be more readily transported, and it costs much less to manufacture than the induction model; but, on the other hand, it is far less effective, and cannot be favorably compared with the more expensive machine as a part of a physician's office-outfit. The *quantity* generated by such a machine is necessarily small; and it is more or less seriously affected by atmospheric changes. In spite of the fact that some of the later authorities on electricity speak in its praise, I cannot give it an unqualified indorsement. It may serve the requirements of scientific institutions admirably; but it is, at best, but a make-shift for the neurologists. I think that I am sustained in this opinion by those who have had experience with the two models when provided with all their latest improvements. I have been experimenting for some months to devise a cheap static machine which patients can use at their homes, and I think I have succeeded in producing a tolerably effective instrument; but I should never advise a physician to purchase one for his own use if he could afford to buy an improved Holtz induction machine.

A STATIC OUTFIT.

It is advisable, in my opinion, to have not less than six revolving and three stationary plates. The revolving plates should not be below twenty inches in diameter. I prefer one with twenty-four-inch plates, for medical purposes, over those of less power.

The *attachments* which should be purchased with such an instrument comprise:—

1. An *insulated platform*. These may be made to seat one, two, or more persons at a time. I use for legs the heavy glass insulators employed by telegraph companies upon their poles. They are very strong and cheap, and have another advantage, namely, that they can be screwed up and down upon a wooden pin which perforates their central orifice. This admits of leveling the platform in case the floor of the room has settled.

2. A *set of electrodes*. This item comprises a large and small brass ball, a metal point, a wooden point, a roller of metal and of wood, an umbrella-electrode, some sponge-covered elec-

trodes, a pistol-electrode, and a ring to hold the chain away from the patient during the applications. The handles should be long, and made of hard rubber or of glass.

3. A *set of brass chains* of varying lengths.

4. A *set of hooks* for attachment to the ends of the chains.

5. A *set of heavy insulated rheophores* of varying lengths.

6. *Three pairs of Leyden-jars* of different sizes. I use those of 3-inch, 1½-inch, and 1-inch diameter, respectively.

7. A *wooden chair* or *stool* which fits the insulated platform.

8. A *connecting brass rod*, for use when the Leyden-jars are employed.

9. Some pieces of cat-skin.

10. Several bottles of well-selected chloride of calcium.

THE CARE OF AN INDUCTION MACHINE.

A few suggestions of practical value may be made upon this subject.

It is advisable, in the first place, that an induction machine should be placed in a perfectly dry room, *well lighted by the direct rays of the sun;* and, when possible, in close proximity to a window which shall allow the sun's rays to fall directly upon the glass plates of the instrument. By this step we obviate dampness, and thus insure the greatest effectiveness of the machine. I have my own in a bay-window where the afternoon's sun has free access to it.

In the second place, the *metal parts* of the machine and the metal electrodes should be *rubbed briskly every morning* with dry chamois-skin or silk. Accumulated moisture on the poles or electrodes is a serious drawback to successful static applications.

In the third place, although the *metal parts* of the machine are shellaced when made, they are apt after a lapse of time to require *re-polishing* with emery-paper, powdered emery, or rotten-stone. A light coat of shellac-varnish should be given these parts after their brightness has been restored, and all grease or moisture thoroughly removed from them.

Again, it becomes necessary at intervals to *oil the bearings* of the wheel-axle and the plate's axle; also to occasionally tighten the leather belt. Thumb-screws beneath the driving-wheel post are provided for this purpose in my model. It is also well to re-

shellac the case if it becomes blistered by the sun. The latter step tends to exclude the entrance of moisture within the case through the pores of the wood.

During the summer months *fresh chloride of calcium should be constantly kept within the case.* It should be renewed whenever sufficient fluid appears in the tray to become evident to the eye. Unless the case is packed with rubber, this method of artificially drying the air must be employed at all seasons of the year. A few drops of petroleum on the floor of the case help to prevent the accumulation of atmospheric moisture upon the plates.

Occasionally the best machine will lose its charge. Should it do so, you will probably find that one of the following causes has led to this result:—

1. The servant or some inquisitive person may have *turned the revolving plates in the wrong direction;* this causes the accumulators to lose their electrical state, and thus to arrest "induction" through the glass plates.

2. *Atmospheric moisture may have entered the case* and been deposited upon the plates. In all models that I know of but my own this occurrence must of necessity be very frequent, as no safeguards exist to prevent it.

3. The instrument may have been left, after an application to a patient, with both the *poles* "*grounded*" by means of the chains dangling from them and resting upon the floor. This oversight may not prove serious in dry, cold weather; but it is never advisable to leave the chains attached to the poles when the instrument is not in use.

4. The plates may have loosened from the axle, and in consequence some may fail to revolve properly. To obviate this occurrence double nuts should be used on the plate-axle.

5. The *combs may have become displaced* so as to touch the glass or to bear an improper relation to the paper collectors.

6. The *case may be too small* for the plates, and thus allow of escape of the electricity to the ground. This will be very apparent to the eye when tested in darkness.

THE CHARGING OF A MACHINE.

It is well to know what steps are necessary to start a static induction machine in case it loses its charge. I have seen a few

instances where the owner of such an instrument has worked himself into a heat of passion as well as of body by fruitless attempts to obtain a spark, while a patient calmly waited with expectancy for the successful termination of his feat. Some of you may have had such an experience. I suggest therefore that you follow the directions given with some regard to their details:

1. See that the *plates and charger are dry.* If not, you can easily render them so by exposing the machine to strong sunlight, and by putting an abundance of chloride of calcium in trays at the bottom of the case. This may require some hours of delay. Always open the door of the case if the sun's heat be used, and *close them tightly* (by means of the milled-screws which perforate the door) as soon as the machine regains its charge.

If you cannot spare the time for these procedures a large alcohol-lamp may be lighted within the case. The air may thus be heated sufficiently to temporarily render the machine useful. I am aware that I have been criticised (in a carping spirit) for offering this suggestion in print; but, as a *temporary expedient*, it oftentimes proves a valuable aid in rapidly regaining a lost charge and rendering an induction machine efficient.

I have frequently known the nozzle of a hot-air furnace (such as is used in giving a hot-air bath to a patient beneath the bedclothes) to be directed into the case of an induction machine for the purpose of drying the plates when very damp. At one time I tried to build a machine with a tube passing through the case by means of which the air in the case might be heated indirectly without opening the door; but I found it impracticable, for many reasons.

2. After you have got the plates thoroughly dry, start them in rapid revolution by turning the driving-wheel *from left to right* as you stand facing it. Now *apply the chargers lightly near to the edge of the revolving wheels for a second or two*, and then sweep them across their face at intervals of a few seconds until the machine starts. The poles should be approximated to within one half-inch, and the chains should not be connected with the poles.

3. If the machine fails to start in spite of these directions, you can then *take a piece of cat-skin* and *warm it thoroughly over a gas-jet.* Then set the wheels in rapid revolution and apply the warmed cat-skin as a rubber (to the plate with the buttons on it) as

close above the metal comb as it is possible to hold it. This seldom if ever fails; but it requires the opening of the door of the case.

4. Be sure that the *poles are well dried* with chamois-skin before the machine is put in action; also that the poles are closely approximated, but not in contact.

METHODS OF APPLICATION OF STATIC ELECTRICITY.

Static electricity can be applied in several ways to a patient. Each of these methods has some therapeutic effects which are peculiarly its own. Moreover, the sensations experienced by the patient during the application are greatly modified by the method employed. For these reasons it is necessary to go into greater detail respecting the management of a static machine than that of any other electrical apparatus in medicine with which I am familiar.

We can apply the static current to a patient in the following ways:—

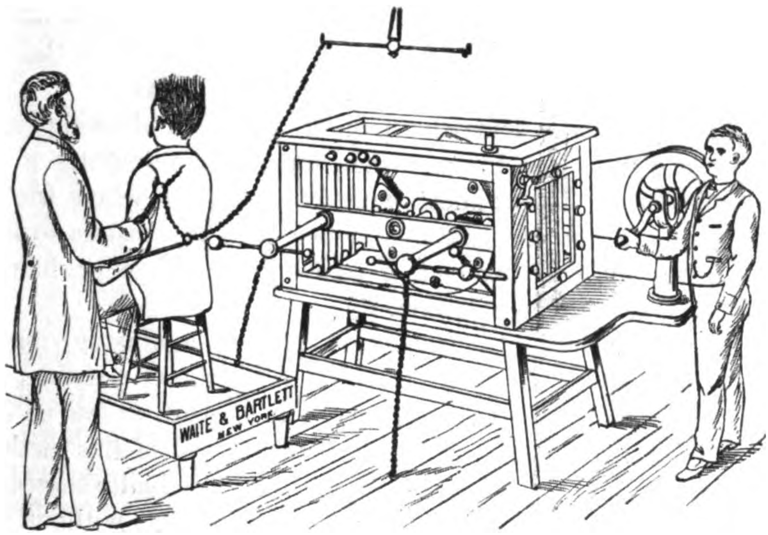
1. By the "*indirect spark.*"
2. By the "*direct spark.*"
3. By the "*Leyden-jar spark*" or "*static shock.*"
4. By "*static insulation.*"
5. By the "*static breeze.*"
6. By the "*static induced current.*"

The Indirect Spark.—To administer static electricity by this method the patient is first placed upon the insulated platform, and sufficiently removed from all surrounding objects to prevent the escape of the charge from the patient to them. The machine is then connected with the patient by a chain, which is either held or simply attached to the stool on which the patient sits. The chain must be sufficiently elevated from the floor to prevent "grounding" of the current. It may be attached to either the positive or negative pole of the machine, according as the operator may desire positive or negative insulation. A chain is then attached to the other pole of the machine, and is "grounded." This can best be effected by attaching it to the gas-fixture or a faucet attached to a constant water-supply. If this is not convenient the chain may be thrown upon the floor, when not carpeted, in case the generating power of the machine is ample.

The *poles of the machine are now widely separated* and the wheels put in rapid motion. You will notice that the hair of the

patient immediately rises; and in a dim light or total darkness you should perceive a peculiar purplish light escaping from the tips of the finger-nails, the hair, and other parts of the body which are more or less pointed. The rapidity of this escape is influenced (1) by the extent of the charge, (2) by the proximity of a part to some surrounding object, and (3) by the condition of the atmosphere, as regards its moisture. As the patient moves his finger-tips near the door-casing or some article of furniture not insulated some of you may be able to perceive this escape of electricity, even in this strong light.

Now we have a condition which is known as "static insula-



THE INDIRECT SPARK.

tion." If the machine is a powerful one it may be carried to a high point.

The final step consists in presenting to the part which you wish to influence a brass ball on the end of an insulated handle. An electrode is connected with a gas-pipe by means of a brass chain. A water-pipe makes an equally good connection. When this ball reaches a certain degree of proximity to the patient you will notice that a discharge of the accumulated electricity occurs in the form of a "spark." The length of the spark elicited depends on the power of the machine, the dryness of the atmosphere, and the perfection of the insulation of the patient. I

frequently have drawn a spark of eight inches by this method. This is known as the "indirect" spark, because the electricity takes an indirect course (through the earth) to form a circuit. It leaps from the patient and escapes to the earth down the gas-pipe or whatever grounding the electrode may chance to have.

The *length* of the "indirect" spark is directly proportionate to the *generating power of the machine*,—supposing, of course, that all other factors in the application are equal (such as the humidity of the atmosphere, the completeness of insulation, etc.).

The *volume* of the spark is modified by the *size of the brass ball* on the end of the electrode. A large ball will produce a heavier spark than a small one.

The therapeutical effects of this method of application will be discussed later. I would call attention, however, to the violent muscular contractions which occur with each spark.

This method is somewhat painful. The withdrawal of a spark leaves a "weal" or lump, which somewhat resembles a recent mosquito-bite. They almost entirely disappear when friction is employed after the application; hence it is my custom to rub the part with my handkerchief, if exposed (the face or hands, for example), after the application.

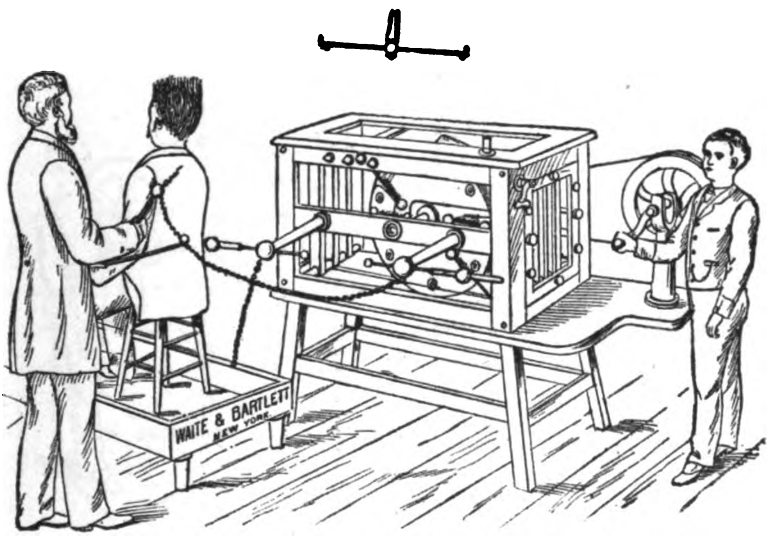
I would caution the reader, in passing, against giving static sparks (by any of the three specified methods) to a patient on his first visit. You are apt to frighten a patient, unless he is well prepared for it. Again, patients grow tolerant of this method of treatment after a while; hence you can gradually increase the volume and length of spark at successive sittings without endangering the patient's confidence in you or creating alarm. You can regulate the length of the spark by the speed of revolution of the plates of the machine.

For some hours after such an application the patient feels a sense of heat at the spot where the spark occurred. This is not at all unpleasant to many. Some patients even speak of it as agreeable.

By using a *wooden ball* in place of a brass one a number of very fine sparks are simultaneously elicited, giving to the patient a feeling aptly compared to a "shower of sand." This electrode is admirably adapted for use about the eye or the face, although this is not the limit of its usefulness.

Finally, it is not essential to this form of application that the clothing be removed; as the finest silk or woolen fabric is not injured by it. This is a great point in favor of static application, especially in the treatment of females.

It is customary to use a second electrode with a *ring of brass* attached to the insulated handle, through which the chain is passed before it is attached to the ball-electrode. This is to keep the chain away from the patient so that sparks will not be caused at points where you do not desire them to occur. A little practice will enable you to handle both with one hand, while you turn the wheels of the machine with the other. Sometimes it may



THE DIRECT SPARK.

be necessary to have the patient stand rather than sit upon the insulated platform while these applications are being made.

Let us pass now to the second method enunciated.

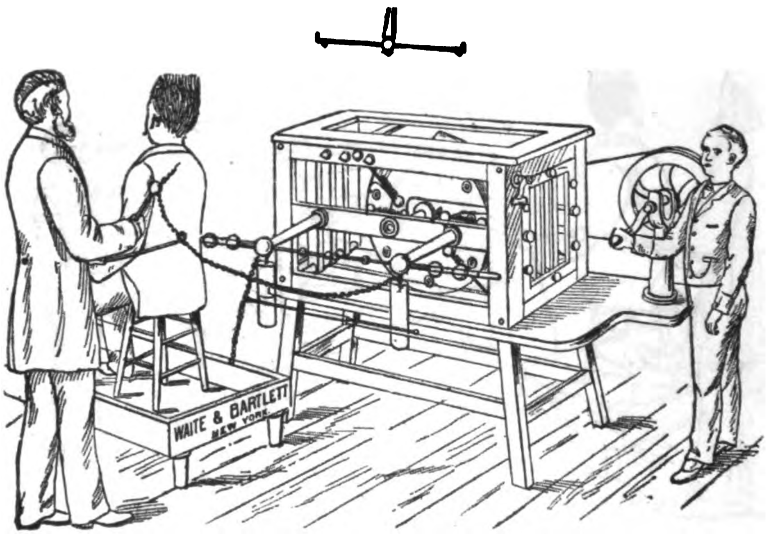
The Direct Spark.—By this method the circuit between the poles of the machine includes the patient only. He sits on the insulated platform, which is connected with one pole of the machine; or one pole may be directly attached to some particular extremity of the patient, when the effects of the current are to be concentrated as much as possible upon that member. The electrode is attached to a chain, which is fastened to the other pole of the machine. The length of spark to be administered is regulated by

the *extent of separation of the poles of the machine* and the speed of revolution of the plates. The farther apart the poles, the longer and more severe is the spark.

The ring-electrode is employed (as in the former method) to protect the patient from an accidental contact with the chain attached to the electrode.

In neither this nor the method previously described are Leyden-jars employed.

I question personally whether the selection of the poles for the attachment of the electrode has much if any influence over the therapeutical action of the "direct" spark. If it has I have



SHOCK WITH LEYDEN-JAR DISCHARGE.

not as yet clearly formulated in my own mind any deduction respecting this point.

Static Shock, or the Leyden-jar Spark.—This method of application is accomplished by first *attaching a pair of Leyden-jars* to the poles of the machine, and *connecting their outer covering of tin-foil by a brass rod.*

The poles of the machine are then brought into close approximation; because the strength of the shock is modified (1) by the *size of the jars* and (2) by the *separation of the poles.*

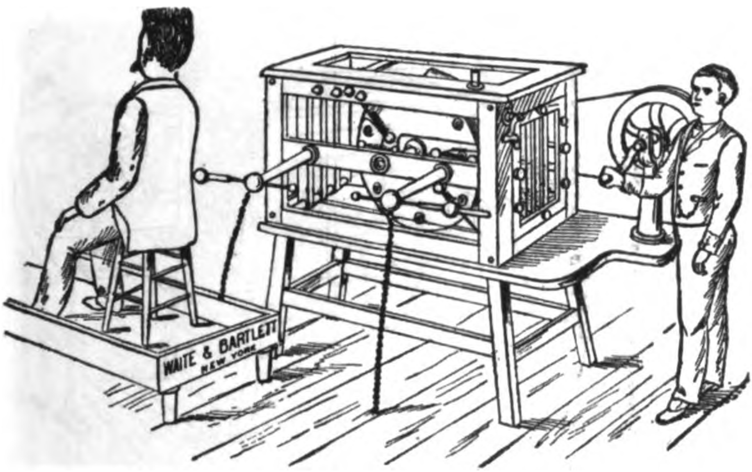
As this method is at best a very severe form of application, it is well to begin with very small jars, and to place the poles as

nearly in contact as possible (without actually touching each other). They can then be separated at will as the exigencies of the case seem to demand.

The chains are arranged in a similar manner to that described in the preceding method (direct-spark application).

This method is best applied to the bare skin. The polarity of the electrode is not to my mind a matter of much consequence.

I advise the reader to handle this form of treatment with extreme caution. I have several times accidentally received a moderate static shock, and I can assure him it is not associated with pleasurable sensations.



STATIC INSULATION.

Static Insulation.—This method has already been described in connection with the administration of the "indirect spark." It is perhaps the most agreeable of all methods of static treatment. The patient is simply charged for a variable space of time (three to twenty minutes) with either positive or negative electricity. The pole of the machine is attached to the insulated platform on which the patient sits or stands. The other pole is "grounded" by a brass chain running to the floor, a water-pipe, or a gas-fixture.

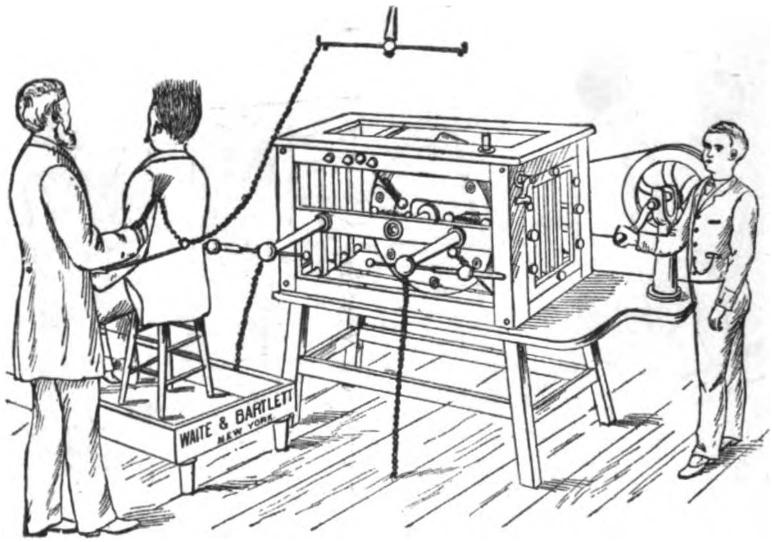
The *poles of the machine are as widely separated as possible* before the wheels are set in revolution.

No pain is experienced. The hair becomes erect unless very much oiled. The patient experiences a peculiar "tingling sensation," with a tendency toward perspiration, if the administration is long continued. If you approach the patient too closely a spark is elicited at the nearest point. This should be avoided, if possible.

Its therapeutical effects will be discussed later.

The Static Breeze.—This method of administration of static electricity consists in the withdrawal of a static charge from a patient by means of an *electrode of metal or wood, which is pointed.*

If the breeze be *indirectly* induced, this electrode is grounded by a chain attached to a gas-pipe, a water-faucet, or placed in con-



THE INDIRECT STATIC BREEZE.

tact with a wood floor when the other connections are not easily accessible. The patient is first insulated (in order to retain a charge), and is then connected with one of the poles of the machine by means of a chain, which he either holds or fastens to the platform upon which he sits. The electrode is then employed.

When the breeze is *directly* induced, the insulated stool is connected with one pole of the machine, and the electrode with the other pole.

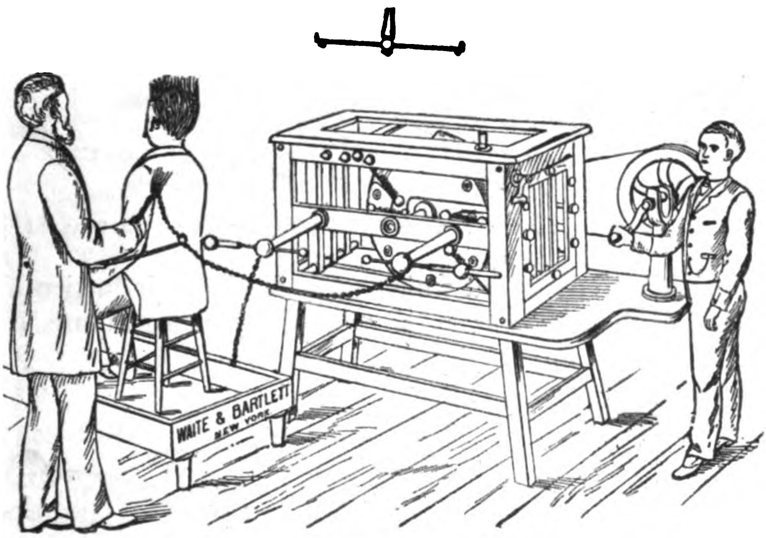
If the electrode be *a metal one*, the electricity is drawn rapidly from the patient at the point which is nearest to the electrode, and a sensation resembling that of a breeze is experienced

at the spot where the electricity escapes. Single or multiple points may be employed on the electrode.

In either of these methods, when the electrode is *composed of wood*, the sensation is modified to a certain extent by the poor conductivity of the wooden point. Most patients compare the effect of such an application to a "shower of sand" concentrated upon the point of withdrawal of the charge.

When this method is employed about the eye, the wooden ball or wooden point is usually preferable to one of metal.

When application to the head and scalp are deemed requisite, a metal cap studded with points is hung over the head of the pa-

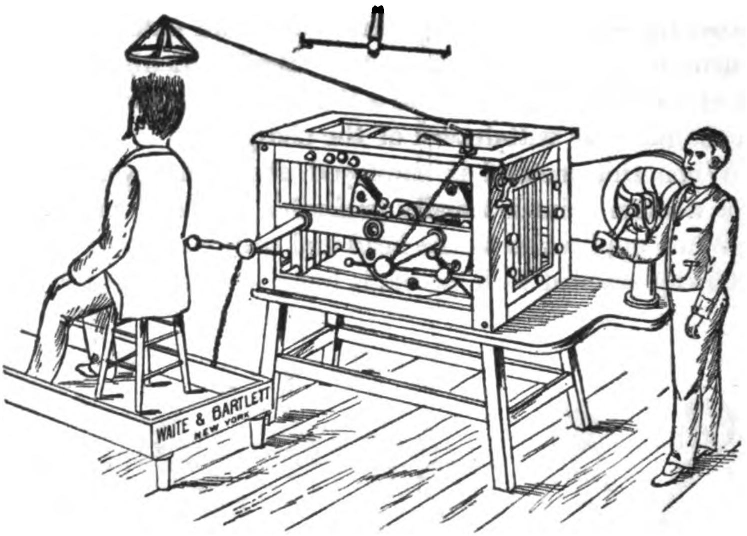


THE DIRECT STATIC BREEZE.

tient by a chain, which is grounded (see cut on following page). This cap is known as the "umbrella electrode." It should not touch the patient's head or hair when he is placed beneath it upon the insulated platform. The numerous points of the electrode draw off the electricity through the hair and scalp, which passes from the machine to the patient and produces a sensation which is particularly pleasant. A "strong wind" is felt permeating the hair and encircling the head.

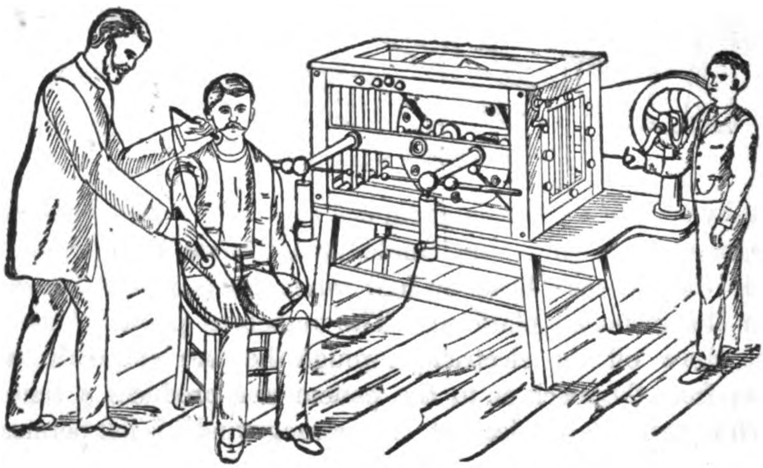
Static Induced Current.—To convert a static machine into what to all practical purposes may be considered a "faradaic" instrument, some slight modifications only are required.

The discovery of this method may justly be attributed to the investigations of W. J. Morton, of New York; although Matteucci



THE ELECTRICAL HEAD-BATH, A VARIETY OF ADMINISTRATION OF THE STATIC BREEZE.

first devised an instrument which gave shocks by induction simultaneously with the discharge of a Leyden-jar (see Figure 795 of Ganot's work on Physics, by Atkinson).

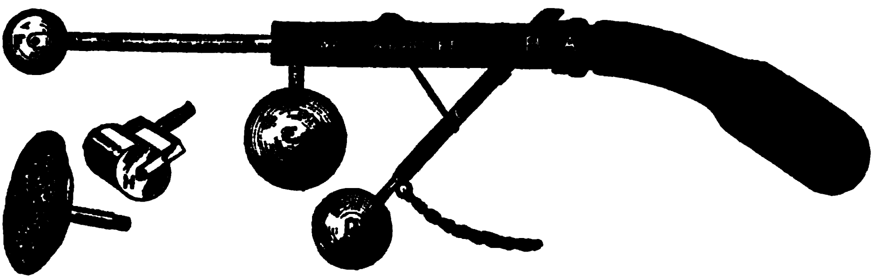


THE STATIC INDUCED CURRENT.

To produce this form of current it is necessary to first *hang a pair of Leyden-jars* upon the arms of the machine. The size of

the jars employed modifies the strength of the current. Hence it is necessary to have jars of different sizes as a part of a static outfit. You now attach the chains—or by preference insulated wires which serve to connect the machine with the patient—*upon the hooks that rest upon the outer coating of the jars.* Finally, you attach to the other end of each rheophore an electrode for use upon the body of the patient. The electrodes may be of metal without any covering, or ordinary sponge-covered electrodes may be employed, care being taken that the insulating handles are somewhat longer than usual.

Before the machine is set in motion *its poles should be approximated closely.* This step is important; because the separation of the poles intensifies the current, as long as a spark will pass



MORTON'S PISTOL-ELECTRODE.

between them. There are two factors, therefore, in determining the strength of the static-induced current:—

1. The size of the jars.
2. The extent of separation of the poles.

Dr. Morton has devised an ingenious electrode which allows of an application of this form of current to a patient without disturbing the poles of the machine; but it is not an essential part of a static outfit, because an interruption of the current can be accomplished without it.

This electrode represents a simple mechanical means of putting into practice the method discovered by him in 1880, of converting the static electric charge into dynamic electricity or current. Electric nerve-and-muscle reactions had previously been obtained by means of the interrupted galvanic and the faradaic currents. It had also been noticeable that the "spark" discharged on a nerve motor-point, or over a muscle produced the characteristic reactions.

But the spark was painful, and difficult to direct accurately, particularly about the face and head. To avoid these objections Dr. Morton arranged this electrode, by means of which the disruptive discharge or spark of static electricity takes place between two brass balls, one of which is in relation with the "ground," while the other is connected to an ordinary moist-sponge electrode. This in turn is applied at the point desired of the patient charged on the insulated platform.

As a result, for every static discharge occurring between the two brass balls there is a dynamic discharge or current at the point where the sponge is applied, and nerves and muscles may be stimulated, or rather "irritated," exactly as by the ordinary interruptions of battery currents, direct or induced.

This electrode is another means of converting static into dynamic electricity, based upon the principle described under the name of "static induced current" by Dr. Morton.

This "static induced current," as has been already stated, was obtained by attaching ordinary sponge electrodes by their connecting rods to the outer layer of tin-foil on the Leyden-jars. The patient in other words replaced the usual connecting rod between these coatings. On putting the machine in motion and causing a spark between the poles, a "current" was felt by the patient, no insulation of course being required. The advantage of this method is that the ordinary Holtz machine may when required be called upon to perform the work of an ordinary faradaic or induction machine.

The greatest event after its discovery, in the history of medical statical electrization or Franklinism, was the invention of the Holtz or induction machine, in 1865. Next in importance, perhaps, is the method discovered and put into practice by Dr. Morton, in 1880, of converting the static discharge into a dynamic discharge or current; and the electrode represented in the above cut is the only novel electrode of any importance not bequeathed to us by the medical electricians previous to 1880.

The difference between the "static induced current" and the faradaic current is this: The former has a *fixed polarity and direction*, and *greater electro-motive force*. It is far less painful also than is the faradaic current when the electrodes are widely separated.

STATIC ELECTRICITY: ITS SPECIAL INDICATIONS AND USES.

In a recent monograph on static electricity[19] I have endeavored to present all that is at present known relative to this form of electrical treatment of diseased conditions, and to afford practical hints respecting the various methods of its application, and the selection and care of the apparatus for generating it. I may be pardoned therefore if I summarize the main deductions which to my mind are applicable to static therapeutics.

It is extremely difficult to formulate general deductions respecting any therapeutical agent. Such attempts necessarily tend to evoke criticism, because exceptions to every general statement may be brought forward as evidences of their unreliability. I am, however, inclined to offer the following general deductions respecting static electrical applications for the benefit of the reader; with the proviso that they may not apply to every case, and that they be not construed too literally:—

1. My experience has not confirmed the view (heretofore advanced by some authors) that the positive pole of a static machine has a "tonic" and the negative pole a "depressant" action.

I have found after repeated experimentation that either pole seems to answer equally well upon most patients. I commonly employ in my office the positive pole, however, because it happens to be the most conveniently connected with the patient.

2. As a curative agent I regard static electricity as of great value.

While galvanism must always hold a preëminent place in electrical therapeutics, because of the chemical effects so obtained, there are certain diseased conditions in which static electricity is unquestionably superior to faradism and galvanism.

3. It has been shown that the static induced current fulfills all the known indications of faradism.

It has moreover two great advantages over the faradaic instrument, namely, that a constant polarity is obtained and a much greater electro-motive force. It is also less painful than the faradaic current.

4. Static electricity possesses a decided advantage in some cases where faradization or galvanization have either given nega-

tive results or have apparently lost their remedial power after their use has been too long continued.

It is a common expedient with medical electricians to shift from one form of current to another from time to time whenever the progress of the case seems unsatisfactory. Under such circumstances Franklinism forms another link to the chain; and greatly aids us when faradism and galvanism have both proven inefficient.

5. I have found heavy static sparks to surpass any other form of electrical application for the relief of contractured muscles.

The sparks are withdrawn from the part so affected in rapid succession for about five minutes.

Post-paralytic contracture, old deformities from preternaturally shortened muscles, and the various forms of obstinated and protracted tonic muscular spasm often yield like magic to the influence of heavy sparks.

6. It is well known that certain forms of pain often disappear at once after static applications.

The most marked type of pain so relieved is the so-called "rheumatic muscular pain," or that observed in genuine muscular rheumatism. I have seen many such cases where one application of heavy sparks to the seat of pain for a few minutes has caused permanent relief.

Again, neuralgias of a distressing kind are often dissipated after a few applications of heavy indirect static sparks for from five to ten minutes at a sitting.

Finally, I know of no other agent which exerts so marked an effect of a happy kind upon the "lightening pain" observed in locomotor ataxia, as does the heavy static sparks.

7. The application of the spark, both by the direct and indirect methods, excites powerful muscular contractions.

This effect is often desired in the treatment of hemiplegia and other forms of motor paralysis.

Some authors recommend the employment of "static shock" for cases of paralysis of long standing; but personally I am inclined to regard this form of application as too severe for most patients.

I have often obtained a complete restoration of muscular power in special nerve-trunks by static sparks alone after the

"reaction of degeneration" was fully developed and all faradaic excitability had ceased.

8. Cases which exhibit a marked impairment of sensation (whether of touch, pain, or temperature) are generally improved in my experience by the use of static sparks over the anæsthetic area more rapidly than by the faradaic or galvanic currents.

I have encountered several very striking cases which illustrate this point admirably, but a lack of space precludes the insertion of their histories.

9. Remarkable effects of static sparks upon that form of baldness known as the so-called "ivory spots" or alopecia areata, have been observed by myself through the courtesy of my friend Dr. F. B. Carpenter, of New York. I have seen several of his cases where he has wrought a wonderful change in the appearance of the scalp after several months of treatment of the bald spots by the "direct" spark. The growth of the hair, which had apparently been totally destroyed over the affected regions, is attributable probably to the rekindling of the circulatory and nutritive conditions of the affected area upon the scalp.

10. As a general tonic and also as a stimulant to depressed nervous functions, "static insulation" seems to be particularly of service.

I employ static electricity constantly by this method in neurasthenia, with marked benefit.

I have observed also remarkable improvement in disturbed visceral functions (such, for example, as dyspepsia, habitual constipation, diabetes, vertigo, asthma, etc.) after the use of static insulation for from ten to twenty minutes at a sitting.

Many such cases have expressed to me the greatest delight at the beneficial effects which such an application invariably produced. For the past three years I have used my static machine almost exclusively as a means of improving the "general nervous tone" of patients in preference to my faradaic or galvanic apparatus. It is much more satisfactory to patients because of its ease of application, and as far as I have observed equally effective as a tonic.

11. I am inclined to think that those authors who have written upon static electricity as a therapeutical agent in a lukewarm spirit have probably been supplied with an apparatus which has been ineffective because it generated too slowly or imperfectly.

The size and number of the revolving plates and their thorough protection from atmospheric changes are factors of the greatest importance.

Many of the static machines sold to the profession are hardly more than mere toys. Any machine which gives a thin spark, even if a long one, lacks one essential factor to success as a therapeutical agent, namely, quantity.

12. I have used static insulation and sparks with satisfaction in the treatment of chronic inflammatory and spasmodic diseases; such, for example, as influenza, phthisis, bronchitis, asthma, laryngitis, neuritis, synovitis, etc.

Three cases of chronic synovitis of the knee-joint of an intractable form recovered completely under my care within a month, under the daily administration of static sparks to the affected joint.

Many cases of bronchitis and asthma have been greatly benefited by insulation and sparks to the chest.

I have used static insulation, followed by the withdrawal of sparks from the spine and abdomen, upon subjects afflicted with dyspepsia, flatulency, and constipation. In many instances this form of electrical treatment gave very marked relief.

The influence of this agent upon visceral derangement is, however, a field for future investigation. It gives promise of happy results. As yet my personal experience is too limited to justify me in formulating any positive conclusions respecting the method which is best employed in individual cases.

13. Static electricity is of value in the treatment of hysterical states and other allied conditions.

Eulenburg[20] has lately published the results of a series of experiments made with static electricity in the treatment of seventy-four selected cases of diversified neuroses. The results obtained showed six radical cures, thirty-three patients very much improved, and thirty-five cases in which other lines of treatment had to be employed in addition to the electrical agent.

The symptoms which proved most amenable to this agent in the experience of this observer were those of neurasthenia, neuralgias, insomnia, and headache.

Among the neuralgias treated this observer obtained the best results when the trigeminus, the occipital, the intercostal, and the sciatic nerves were attacked. He recognizes, in common with

most observers, one great advantage of static applications over the employment of general galvanization and general faradization, as well as local applications of these currents, viz., that the clothing of the patient does not have to be removed. This advantage cannot fail to strike any one who employs this form of electricity as a great one. It enables the physician to treat patients with no appreciable waste of time during limited office hours. It saves the patient the necessity of exposure of the person. Several patients may also be treated at the same time when deemed advisable.

The only criticism which I would make upon Eulenburg's observations and others who have worked in this field would be that some doubt is present in my mind respecting the generating capacity of the apparatus commonly employed by those who have tested this agent. The static machine which I presented to the profession some years since, as the result of several months of continued experimentation, so far exceeds all other static machines with which I am familiar in its generating capacity that the results obtained by myself are vastly more satisfactory than those which I previously had with a machine of less power.

THE MEDICAL DYNAMO.

Since the introduction of Apostoli's method of treating uterine fibroids by very high galvanic currents, the necessity of a new form of generator seems to have arisen in the minds of some medical men. Dr. F. H. Martin, of Chicago, has lately introduced to the profession a modification of the dynamo (so useful in commercial channels) which he states serves the purposes of medicine with admirable success. Currents generated from such an instrument are practically constant and seem to possess all the chemical properties of galvanism.

It is claimed by Dr. Martin that this dynamo is so constructed as to be of particular service in electrolysis and in cautery applications. He states that its current can be graduated to the point desired without decreasing the speed of revolutions; that *cautery applications* (requiring quantity) and *electrolysis* (requiring current-strength) can be performed simultaneously (?) from the same instrument by a mechanical attachment; and that a "safety-device" prevents the machine from reaching a point where the current generated can do harm to the patient or the machine itself. He

estimates its current strength as equal to 150 Leclanché cells (210 volts). It is also claimed that the medical dynamo possesses one great advantage over a galvanic battery, viz., that the current-strength can be graduated at the will of the operator to one-hundredth of a volt; whereas, in a galvanic battery, one volt expresses the extreme limit of fine gradations. It might be pertinently asked in what physical conditions less than one volt of electro-motive force can be used as a therapeutical agent.

This machine is the invention of E. A. Sperry, and is manufactured by the McIntosh Galvanic and Faradaic Co., of Chicago.

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MEDICAL CHEMISTRY AND TOXICOLOGY.

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PHILADELPHIA.

POISONING BY ARSENIC.

James Ritchie[1] has made the statement that in a period of eighteen months he has met with three cases of poisoning from arsenical wall-papers. The symptoms were those of gastro-intestinal irritation, persistent or recurring frequently. The wall-paper of the rooms tenanted by these patients contained sufficient arsenic to give a characteristic result by Reinsch's test. Other cases like these have been reported by Chadwick[2] and other writers, but it is exceptional to find a report conclusive as to the connection between the paper and the symptoms. However, W. Everett Smith,[3] in a recent paper, was enabled to settle decisively the cause of the symptoms of irritations of the eyes, stomach, and bowels by analysis of the urine. Six ounces of urine yielded crystals of arsenic sublimed from the mirror in a tube. The arsenic disappeared and the patient recovered when removed to apartments not hung with arsenical paper. In the subsequent discussion Davenport stated that the German Government had, during the past summer, passed a new law which allows manufacturers to incorporate two and a half grains of arsenic to the square yard of woven goods, provided the pigments are in an insoluble condition. The presence of arsenic in any arsenical pigment is forbidden if the arsenic is a constituent part of the color; but if present as an impurity the law does not apply.

The liability to receive arsenic into the body from the dust in the atmosphere and from the coloring matter of clothing may at times present a difficulty to the legal chemist. Having found the poison in the body, the analyst may have put to him the query as to the admission from some non-criminal source.

In order to determine if the body can imbibe arsenic from the

soil of the cemetery in which it is buried, Garnier and Shlagdenhauffen[4] made three sets of experiments:—

First. In examination of various soils revealed the presence of arsenic, especially in those of a red color. It exists most likely as arseniate of iron, a salt completely insoluble in water at the natural temperature of the soil. It is improbable that percolating rain-water should dissolve it out.

Second. A calcareous yellow ferruginous soil free from arsenic was mixed with twice its weight of water, and to this was added a definite quantity of a weak solution of arsenic trioxide. After six or seven months the water showed no trace in solution. The arsenic had joined the iron in the soil as iron arseniate.

Third. Into the arsenic free soil of a cemetery, paper packages of iron arseniate, calcium arseniate, and potassium arseniate were introduced, and after some time the surrounding soil examined. No arsenic was found disseminated except near the calcium arseniate, where a minute trace was recognized by Marsh's test. The potassium arseniate had entirely disappeared, changed into insoluble compounds by the soil.

The conclusion reached was that the *natural arsenical compounds of soils are not likely to diffuse into a buried corpse.*

In order to determine the influence of arsenic upon putrefaction of the corpse, Zaaijer[5] investigated sixteen corpses of persons poisoned by arsenic and compared the published accounts of sixty similar cases. Among other important conclusions he states that putrefaction is hindered in poisoning by arsenic, alcohol, corrosive sublimate, potassium cyanide, thymol, chloride of zinc, and chloride of antimony. In seven arsenic cases in his experience by the end of six years the soft parts had entirely disappeared. The condition known as mummification is of frequent occurrence, and has no relation to arsenic poisoning. There exists no so-called arsenical mummification.

It has been maintained that cacodylic acid is an exception to the rule that compounds containing arsenic have poisonous properties. Although Lebahn observed death in rabbits after injections of 2.3 grams of cacodylic acid, his results have not been considered conclusive, because he did not by testing determine the absence of arsenious acid as an impurity. Marshall and Green[6] find that arsenious acid is a frequent contaminant of commercial cacodylic

acid. They administered to dogs as much as 3 grams of pure cacodylic acid without causing death, though salivation, vomiting, and purging were observed. Three grams were found fatal in the case of one small dog. On the whole the authors consider that cacodylic acid has general effects akin to those of arsenic, but less permanent.

Paralysis due to arsenic has been studied closely by Holst[7] in a case poisoned by a table-spoonful of Schweinfurt green. No gastric disturbances except vomiting and slight abdominal pains occurred during the first twenty-four hours. Eight days later there appeared a rapidly progressing weakness in the lower limbs. Six weeks after the accident there were found complete anæsthesia and paralysis of the lower extremities, with muscular atrophy and some loss of sensibility and motion in the upper limbs. The patellar reflex was abolished. The degeneration-reaction was distinct in all four extremities. The bladder and rectum remained intact. Under treatment by baths, iodide of potassium, and good feeding the patient gradually recovered.

POISONING BY BARIUM COMPOUNDS.

In order to test the correctness of the opinion held by Neumann, that in chronic intoxication by barium salts the metal is not diffused through the system, Linossier[7] made experiments on rabbits. Mixed with food, increasing doses of 50 centigrams to 1½ grams of barium carbonate were administered to a rabbit. As soon as dangerous effects appeared the dosage was suspended.

After thirty days of treatment with the barium carbonate the animal was killed and a careful analysis made of the tissues.

All the organs contained barium, but in varying proportions. The bones contained the largest proportion, 0.56 to 1000 parts of ash; the kidneys, brain, and spinal cord showed a less amount, the liver still less, and in the lungs, muscles, and heart only traces could be found. This investigation shows that barium, in respect to localization, is not different from other poisonous metals.

POISONING BY BISMUTH.

It is generally supposed that the toxic action of bismuth salts is due to adulteration with arsenic. The gastro-enteric symptoms usually encountered are similar to those produced by arsenic, but

in addition there are buccal symptoms like those of mercury, which are probably due to the fact discovered by Dubinsky, that bismuth is eliminated in large amount by the saliva. Dalché[8] reports two cases that tend to overthrow the commonly-received opinion. The first, a woman, had an extensive burn of the back and left arm. A dressing of bismuth subnitrate was applied and renewed every two days. In two weeks there was slight pain in the throat, with dysphagia. A white false membrane appeared on the soft palates, tonsils, and lower lip. It spread, became covered with blackish mucus, while the breath grew fetid. As the old false membrane loosened and became detached, membranes formed in new places in the mouth and throat. In a few days diarrhœa set in, with vomiting and albuminuria. Bismuth was detected in the fæces and the urine. On *analysis*, the compound used was found *absolutely pure.* It was discontinued, but the vomiting and diarrhœa persisted for two or three days. The buccal symptoms lasted for a month.

The second case, a girl, after excision of the knee had the wound dressed with bismuth subnitrate. In a fortnight, without fever, there were anorexia, salivation, and stomatitis. Bismuth was detected in the urine. In view of the fact that enormous doses of the subnitrate have been given internally without injury, these results of its use in wounds must be considered remarkable. Dalché and Villejean[9] have made an experimental research on this toxic action, taking care to use a pure salt of bismuth. They injected hypodermatically a 20 per cent. solution of the subnitrate into a guinea-pig and three dogs, with a fatal result in all in a few days. They noted first a stomatitis, with a brownish-violet line on the gums, and spots of the same color on the inside of the cheeks and lips. The gums and the spots sloughed, leaving ulcers with a blackish border. Ptyalism with fetid breath was observed. The urine turned dark, throwing down a blackish sediment containing bismuth. In some cases albuminuria and tube-casts were found. Finally enteritis with dysenteric symptoms was developed.

POISONING BY CARBOLIC ACID.

A young married woman in the care of Dr. Minot[10] took, with suicidal intent, seven fluidrachms of liquid carbolic acid of 95 per cent. She became unconscious and remained so for three hours, when violent vomiting set in. There was a frequent, weak pulse

and shallow respiration, but no carbolic odor on breath. For a day or two there remained vomiting and gastric tendencies, with smoky, albuminous urine. On the ninth day the case was discharged well. The only antidote used was sodium bicarbonate.

Simon[11] has reported a case of poisoning by carbolized cotton-wool applied to an ulcer 5 to 6 centimetres in length in a child 22 months old. In two days after the first application the temperature was 101.8° F. and pulse frequent. Vomiting set in, uncontrolled by medication. The face turned pale and the extremities became cold, while the temperature rose to 103° F. There was extreme weakness and suppression of urine. The carbolized dressing was abandoned, and in thirty-six hours recovery was complete. The urine now came away with the characteristic smoky color. Simon deprecates the use of carbolic acid in infants under two years of age. They have a relatively feeble power of resistance to it. Lotions and dressings with dilute solutions have often sufficed to give them symptoms of intoxication. Monti[12] reports a case of a child who was taken with convulsions and vomiting five hours after the application to an eczema of compresses saturated with carbolated oil 1 part in 500. Tordeus describes a case of an infant who took a little carbolic acid. Consciousness was lost in a few minutes, respiration was soon suspended, and the pulse imperceptible. In five minutes the child was dead. Winslow observed a child of 4 years who took 8 grams of carbolic acid and was seized with clonic spasms, ending in tetanus. Reichert estimates that one-third of the cases have convulsions, ending in suspended respiration.

Larne[19] reports a case of poisoning by crude carbolic acid taken by mistake. The patient was promptly treated with antidotes and the stomach-tube, but notwithstanding all that was done died on the sixth day from tetanic symptoms that supervened four days after the poisonous dose was taken. His earlier symptoms were great epigastric pain and tenderness, violent retching, fullness of the head, scanty blood-colored urine, carbolic odor on breath and in washings of the stomach.

The autopsy revealed slight inflammation of pharynx and œsophagus, though stomach and intestines were normal. The arachnoid and pia mater of the brain and upper part of spinal marrow were congested.

POISONING BY CARBON DISULPHIDE.

Ross[14] has made a very careful study of the symptoms produced by this agent on workers in india-rubber factories. His cases were two men of twenty-four years each, with a record of sound health previously. After eight or nine months of exposure to the fumes of carbon disulphide in the "curing-room" they made complaint of many symptoms, of which the following are the most characteristic: After a few weeks burning sensation in the hands and face, which were red and hot to the touch. Several weeks later there came on restlessness, numbness, and tingling, with progressive weakness of the limbs. On resting a few weeks these symptoms disappeared, only to return soon after work was resumed. Walking became difficult and prehension weak and tremulous. There were loathing of food, loss of flesh, and emaciation. The memory became affected and sleep was much disturbed. Mental depression and delusions existed in these as well as in other cases. Temporary relief from the miserable feelings was obtained by inhalation of the fumes. There was a certain resemblance to the effects of chronic alcoholism, ending like it in paralysis and loss of the knee-jerk. Absence from the factory was followed by improvement, and after some months hardly a trace of paralysis remained.

POISONING BY CHLOROFORM AND CHLORAL.

So common is it to find traces of arsenic as a contaminant that one is not surprised to learn from a report of Scholvein[15] that in examining German chloroform he has frequently met with samples that gave a distinct reaction with silver solution which he now finds to be referable to a contamination with arsenic. The source of the arsenic is somewhat difficult to determine. The action of chloride of lime containing arsenic on the alcohol might give rise to organic arsenical compounds which would pass over in the distillation; but, on the other hand, upon distillation of the defective chloroform the arsenic is concentrated in the residue. It is also possible that the contamination may have been due to the use in the manufacture of sulphuric acid containing arsenic. An important method of detecting chloroform, named after Ragsky, depends on the fact that when chloroform vapor passes through a red-hot tube it evolves chlorine and hydrochloric acid. Luedeking[16] has made experi-

ments to determine the effect of decomposition upon chloroform, and reports that no substances are thereby generated which would vitiate the tests by the Ragsky method. "Chloroform when it has caused death by inhalation can with certainty be detected in the body four weeks after death, and notwithstanding its volatility it is certainly retained in the viscera in large amount during this time."

As a clue to the fate of some portion of the amount taken, Kast[17] quotes results of Mylius to the effect that when chloroform is administered to a dog there is a great increase of sodium chloride in the urine passed the next day. Kast, repeating these experiments, found the same increase of chloride after chloroform narcosis, but no such effect after ether.

Experiments on man yielded a like result. Chloral had no such effect, but left the body as urochloralic acid. Greene[18] reports that methods of separating chloral hydrate from animal mixtures have been studied by Tiesenhausen. In practicing extraction as for alkaloids the best results were obtained by agitation with absolute ether and with ethyl acetate.

From seventy-five cubic centimetres of liquid five milligrammes of chloral hydrate can be separated by two agitations, but one milligramme remains unseparated after repeated agitations. Hofmann's test was found to be the most delicate, detecting one sixty-thousandth of a gramme. It depends on the formation of benzoisonitril, recognized by its odor when an alcoholic solution of sodium hydrate and aniline is warmed with chloral. In addition there may be employed the test which gives a deep-blue color by the action of strong potassium hydrate solution and α or β naphthol, detecting one twenty-four-thousandth of a gram. The author recommends the separation of chloral from the gastric contents by agitating with ether. By this means enough can be had to give results with the naphthol reaction. Distillation was necessary for the most satisfactory results when the blood and urine were under examination. The lungs and brains of poisoned animals gave no sign of chloral.

POISONING BY CHROMIUM.

Cases of acute poisoning from chromic acid and the chromates are so rare that it may be well to translate in brief the account of one presented by Tisné.[19]

A vigorous man aged 45, had received three applications of chromic acid to a fungous growth on the gums without any bad result. At the fourth application the dentist, being hurried, used the acid too freely, and some of it mixed with saliva was swallowed. It gave him no other sensation than an acrid taste and a slight burning in the throat. After walking one hour he experienced a severe pain in the nape of the neck, followed by vertigo and some nausea, though vomiting did not appear for half an hour. It was then abundant and painful, consisting of a ropy, green fluid. Great pain in the nucha persisted with vertigo at the slightest movement. His face was pale, extremities cold, pulse thready and compressible, pupils slightly contracted. There were traces of the application in the mouth; the pharynx and the veil of the palate had a diffused red color. The treatment was limited to milk and eggs, with champagne *frappé* as a stimulant.

After some nine hours the symptoms were greatly ameliorated and copious urination occurred. A few drops of silver nitrate added to the urine gave the characteristic red precipitate of chromate of silver.

Pander[20] has made a study of the physiological action of chromium, using for his experiments the double lactate of chromium and sodium. The following is an abstract of his researches:—

Chromic acid and its salts produced both acute and chronic symptoms, salts of chromic oxide causing only chronic or, at most, subacute forms of poisoning. The chromic acid compounds were found to be a hundred times more toxic than those of chromic oxide. The acute forms of poisoning show themselves by disturbance of the respiration and of the central nervous system; chronic forms affect the skin and also the mucous membranes when air containing finely divided chromic oxide is allowed to come into contact with them. The heart's action was not directly affected by any of the preparations. The chief as well as the earliest morbid changes appeared in the kidneys under the form of parenchymatous nephritis, followed by the interstitial form; also in the gastro-intestinal tract, where inflammation, ecchymoses, and swollen follicles were found. There were also morbid appearances in the blood and in the spleen. In chronic cases the spleen was shrunken and the hepatic parenchyma had a cloudy appearance. Chromium was found to be absorbed both when given hypodermatically and also

when administered by means of the gastro-intestinal tract, at least when soluble compounds were employed. Chromic acid preparations were absorbed with great rapidity, both by the skin and the stomach. When in very small quantities chromic acid and its salts were reduced to chromic oxide. The elimination of chromium took place mainly by the kidneys, but also to some extent by the liver and bowels. Death was caused in acute cases by arrest of respiration and disturbance of the central nervous system; in chronic cases by morbid changes in the blood, the kidneys, and the digestive tract. Pander was unable to find any indication as to the value of chromium as a therapeutic agent.

POISONING BY COLCHICINE.

Butte[21] has studied the action of fatal doses of various purgatives on dogs. He found that colchicine, veratrine, croton-oil, and colocynth produce inflammation and ulceration of the intestines. While colchicine and veratrine both cause hyperæmia, that due to colchicine is more intense, leading to submucous ecchymoses; it is also more extensive, involving three-fourths of the small intestine. The large intestine is inflamed to a slight extent only. The ulcerations due to colchicine are sharply defined and small, those of veratrine larger and ill-defined. An experimental study made by Mairet and Combemale[22] on cats and dogs, has demonstrated that colchicine has irritant effects on the kidneys and other organs beside the intestines.

It causes hyperæmia of the joints and the marrow of the bones. Although eliminated by various organs, the urine is the chief outlet. Owing to the slowness of this elimination, relatively small doses given at short intervals may accumulate to a poisonous degree. The symptoms are about the same in kind, whether the poison is given by the stomach or hypodermatically, though they are earlier and stronger in the latter case. With respect to the chemistry of colchicine, important information has been furnished by a research of Laborde and Houdé,[23] of Paris. They extract pure crystallized colchicine in a novel way, avoiding the use of mineral acids and acetic acid, alkalies and alkaline earths, all of which change *colchicine* into *colchiceine*, a much less active principle. Their crystallized product has reactions in the main like those of the amorphous variety commonly used. It does not give a permanent green

color to Draggendorf's test with ferric chloride. The authors found that this reaction occured with no samples but those contaminated with colchiceine.

While colchicine is intensely and persistently bitter, colchiceine alone is not at all so. Houdé regards colchicine as a nitrogenized neutral principle, $C_{46}H_{27}N_{14}O$, from which colchiceine differs by the absence of an equivalent of methyl-alcohol. He thinks there is good ground for considering *colchicine* as a *methyl-colchiceine.*

For *toxicological researches* the following process is recommended: The organs, well cut up, are exhausted by maceration in alcohol of ninety degrees, holding some tartaric acid in solution; the spirit is distilled off in vacuo; the residue, after filtering out the fatty substances, is shaken repeatedly with chemically pure chloroform; and finally spontaneous evaporation yields pure colchicine in the amorphous state. Although simple, the method is guaranteed to be reliable and sensitive. Most of the poison is found in the stomach, the bowels, the liver, and the pancreas; the saliva and kidneys contain least, while the blood never shows a trace.

POISONING BY COPPER.

In making an experimental critique on the toxic properties of the salts of copper Roger[24] was led to the following conclusions: First, the salts of copper are very toxic when injected directly into the circulation. Second, they are not nearly so toxic when introduced into the alimentary canal, the difference being due to the fact that part of the poison is rejected by vomiting, part is neutralized in the stomach, particularly in contact with glucose, and part at last arrested and deposited by the liver. Third, they cause paralytic accidents, following in the higher animals a regular ascending march, ending in death by arrest of respiration. Muscular contractility is rapidly lost, but concomitant with troubles of the nervous system which forbid that we should consider copper a poison to the muscles exclusively. Moulin[25] makes the following summary: First, it has not been demonstrated that large doses of salts of copper mixed with food have ever caused death. Second, except perhaps in a case of suicide, acute poisoning by these compounds ought not to occur, not only because of their horrible taste, but also of their energetic emetic properties, which suffice to

evacuate the stomach. Third, medium doses in the beginning act as ordinary emetics not followed by any particular discomfort, but tolerance is rapidly produced and the administration may be continued for six months without danger to the health either at the time or afterwards. Fourth, the amount of copper necessary to give a proper color to green vegetables is absolutely inoffensive; there is no medical fact better established than that of their entire harmlessness. These conclusions appear to justify the recent decision of the New York Board of Health,[26] that the following goods are declared to be exempt and permitted to be sold under the provisions of the act:—

Canned peas or beans in the preparation of which copper has been used, provided that the proportion of metallic copper shall not exceed three-fourths of a grain per avoirdupois pound of peas or beans, equivalent to three grains of crystallized sulphate of copper, and that the same be plainly stated on the label.

POISONING BY CORROSIVE SUBLIMATE.

Owing to the extensive use of corrosive sublimate for antiseptic dressings, cases of poisoning from it of late have become quite common. Occasionally the antiseptic is given by the mouth through mistake, as in the case of a child aged three years under the care of Church.[27] The child's mother, a maternity nurse, had obtained a solution of corrosive sublimate 86 grains in the ounce to be diluted to make lotions for disinfecting the hands. The child had administered to it one drachm by mistake for castor-oil; this is equal to $10\frac{3}{4}$ grains of the poison. It caused immediate vomiting, the vomited matter being soon tinged with blood. There were intense thirst, drowsiness, weak pulse (180), temperature 105.6°, dilatation of the pupils, and twitching of the eyelids and eyeballs. The urine was suppressed. There were occasional discharges of bloody mucus from the bowel. There was no salivation, but profuse mucous discharge from the nose. Death occurred twenty-two hours after taking the poison. Post-mortem examination revealed whiteness of gums; a band of intense congestion three inches wide along the lesser curvature of the stomach; duodenum normal; mucous membrane of the small intestines of a grayish-yellow color, in the lower part greenish; and in the sigmoid flexure was a patch of congestion about the size of a florin.

A chemical examination was made of the mucus from the nasal cavity, the contents of the stomach and duodenum, serum from the pleural cavity, ejecta from the bowels six hours before death, a portion of the liver and one kidney, and *not a trace of mercury could be detected.* Either the mercuric chloride which had caused death had been dissolved and eliminated, or had been reduced to minute globules of metallic mercury, which escaped notice at the post-mortem examination.

The digestive organs are apt to be profoundly affected, even in the cases where the sublimate is absorbed from wounds and cavities not connected with the alimentary tract. This was pointed out by Butte[28] in a recent paper. He found that when the poison has been absorbed in sufficient quantity diarrhœa comes on a few hours after the dressing of the wound, at first watery but afterwards sanguinolent, and accompanied by tenesmus, pains in the rectum, and abdominal colic, together with nausea and vomiting. Stomatitis and salivation are rarely observed. There is albuminuria, varying in degree; the urine contains lymphoid and epithelial cells with granular casts. There is severe headache, with slight transient disturbance of the intellectual faculties and insomnia. With the mind clear to the end, sensation is less acute, the sight becomes dim, the pulse is weaker, the pupils contract, the temperature falls, and erythema appears, often in a very exaggerated form. The most important lesions are found in the alimentary canal, especially in the large intestines. The inflammation is generally limited to the colon. There is violent hyperæmia of the mucous membrane, and the epithelium may be easily detached; the mucous membrane, which is superficially necrosed in some parts, is in others covered with a diphtheritic coating infiltrating the underlying layers. Characteristic lesions are also found in the kidneys. These organs show the changes of acute parenchymatous nephritis. At the periphery and in sections striæ are seen of irregular size and of a yellowish-white hue, composed of deposits of amorphous masses of oxalate of lime, in the hooked tubules. Salkowsky succeeded in producing these lesions experimentally in rodents. Prévost showed that the calcareous deposits were caused by the decalcification of the bones, which in this form of poisoning lose as much as 9 or 10 per cent. of their solid constituents. The peritoneum is sometimes slightly injected. The liver is generally pale and anæmic.

The other organs are unaffected excepting the brain, which in an experiment of Doléris was found to be slightly congested. The course and duration of the affection are variable. In some cases the patient after a time gets quite well, whilst in others death occurs in from three to fourteen days.

So numerous are the deaths now reported from the antiseptic use of the sublimate that it is not surprising to read from Fleischmann[29] an appeal to the profession to cease its use in obstetric practice. In a recent case of his two injections were given at the time of examination.

The second was soon followed by severe abdominal pain, serous diarrhœa, and vomiting of bile. In six days, after showing certain characteristic symptoms of mercurial poisoning, the woman died, in the mean time having been delivered without difficulty. The autopsy revealed spongy and swollen gums, ulcers of the tongue and pharynx and ascending colon, with acute parenchymatous nephritis.

It has been generally believed that the administration of potassium iodide facilitates the elimination of the poison in cases of chronic mercurialism.

It is not easy to reconcile this to the results obtained by Souchow,[30] who found that when a patient took potassium iodide in conjunction with the mercurial the elimination of mercury commenced later, and the quantity eliminated was relatively less than when the mercurial was given alone. Again, it was less daily if the iodide was given after the mercurial course.

In fact, the iodide appears to retard instead of hastening the elimination of mercury, and seems to be worse than useless for chronic mercurialism.

The solubility of poisons is sometimes of importance in legal chemistry. It is reported that Stuetz[31] has found that by adding 7½ grains of citric acid to each quart of water used in making solution of bichloride of mercury there would be no reduction of the $Hg\,Cl_2$, and also no precipitate when albuminoid solutions are admixed.

For dissolving corrosive sublimate distilled water only should be used, as by natural hard water the oxychloride is precipitated out. In making the ordinary solution of 1 part in 1000 over 80 per cent. of the sublimate may thus be lost, and the solution contain but 1 in 5000 parts in reality.

Letulle's[32] investigations go to show that localized mercurial palsies are due to circumscribed lesions of peripheral nerves. In mercurial palsies the electro-contractility is unimpaired, there is no atrophy, and the tendon reflexes persist. In these respects they are unlike head palsies.

The lesion caused by mercury is a progressive destruction of the myelin with preservation of the axis cylinder. The trophic changes are pigmentary and periaxile.

POISONING BY HYDROGEN SULPHIDE.

The untoward effects sometimes following the use of Bergeon's method of administering this gas give peculiar interest to the researches of Julius Pohl.[33] He injected into the lymph-sac of frogs a neutral solution of sodium sulphide, which he used as representing the form taken by hydrogen sulphide when absorbed into the blood. This produced narcosis, paralysis, slow and feeble action of the heart, stopping in diastole. Injected into the jugular veins of rabbits it caused cerebral convulsions or paralysis, labored respiration, lowered blood-pressure, and death. The blood was darkened, but still showed oxyhæmoglobin and no *sulph-hæmoglobin*. Further experiments tend to the conclusion that these effects were not due to oxidized products, nor to the reduction of the hæmoglobin, but probably to the direct action of the sulphide on the tissues.

POISONING BY LEAD.

In examining portions of the bodies of two persons who died suddenly from lead-poisoning, Blyth[34] has obtained quantitative results of some interest. In one case he separated from the liver lead as sulphate one-third of a grain, from one kidney about one-thirteenth of a grain, and from the brain an appreciable amount. In the other case he estimated that the cerebrum contained about a grain and a half of lead calculated as sulphate, and the cerebellum about one-quarter of a grain. Further he remarks:—

"There has hitherto been no reasonable hypothesis to explain the profound nervous effects of the assimilation of minute quantities of lead, but if it is allowed that lead forms definite compounds with essential portions of the nervous system, it may then be assumed that in effect it withdraws such portions from the body; in other words, the symptoms are produced not by poisoning in the ordinary

sense of the term, but rather by destruction,—a destruction it may be of important nerve-centres."

Dercum[35] has reported a case presenting some remarkable features. The lady, aged forty, suffered from nervousness, insomnia, general pruritus, and small patches of eczema. She had loss of appetite and extreme weakness. There was no paralysis nor sensory impairment, but occasional colicky pains, exaggeration of the knee-jerk, and a short, faint-blue gingival line of doubtful significance. Notwithstanding the absence of characteristic signs of plumbism, Marshall obtained from 400 c. c. (f℥xiv.) the relatively large amount of 5.2 milligrammes (0.08 grain) of metallic lead. There were evidences of the presence of lead in the saliva and the perspiration. That lead is not more frequently found in the urine of cases of plumbism is probably due to superficial methods of analysis. A proper analysis is so tedious and expensive that few inquirers care to work in this field.

Putnam[36] has had made eighty-six urine-analyses for lead in the healthy and sick, with the result of finding lead present in the surprising number of forty-eight cases. But as most of these cases were chosen because of their exposure to lead by occupation or otherwise he makes allowance for this fact, and concludes that, so far as these figures are a guide, in not more than fifty per cent. of the community at large can lead be detected in the urine. The exceedingly delicate method of analysis may have a value in accounting for this remarkably high estimate. It was first devised in its present form by Professor Wood, of Harvard University. The patients took five or ten grains of potassium iodide three times daily for four or five days, and then collected a quart of urine which was acidified with acetic acid and sent for examination. By Wood's method the analyst first evaporates the urine to dryness and fuses it in a crucible with a little pure nitre till it becomes white. When the crucible is cool, dilute H Cl is added *hot* to extract the residue. It is then filtered and the filtrate treated with ammonia to alkaline reaction to precipitate the phosphates and iron. Ammonium sulphide is added at the same time to throw down the lead and iron as sulphides. This is washed three times by decantation with hot water; then water acidified with H Cl is added and the whole allowed to stand until the next day. It is then filtered through a small filter, the filtrate rejected, and the

residue washed. A little pure nitric acid is then added drop by drop to dissolve the sulphide of lead left on the filter and carry it through as nitrate. This filtrate is collected in a watch-glass, evaporated to dryness, and the final test made by adding a drop of water and a crystal of potassium iodide. The production of a yellow precipitate denotes lead.

In a survey of the eighty-six persons whose urine was studied Putnam finds worthy of note, *first*, that the urines of persons known to be in perfect health were almost all free from lead; *second*, that in neurasthenia and epilepsy the cases in which lead was found were in a decided minority; *third*, that in proportion as these nervous symptoms were associated with organic disease the number of lead cases increased; *fourth*, that among the cases of organic disease those in which lead was found with the greatest regularity were cases presenting symptoms of chronic diffuse neuritis and chronic myelitis, especially of the motor tracts of the spinal cord; *fifth*, that those which presented the least sign of cachexia were those in which lead was not present; *sixth*, that the cases of progressive muscular atrophy showed no lead.

David S. Stewart[37] has made an analysis of 64 pronounced cases of lead-poisoning traced to the consumption of cakes dyed with lead chromate.

He states that these are probably but a small part of the whole number affected; subsequent investigation has brought numerous other cases to light and convinced him that many still exist unrecognized. There seems, indeed, little doubt that much sickness and many deaths in the past attributed to other causes were due to lead-poisoning introduced through the products of the bakery.

Most of the 64 cases analyzed exhibited some of the ordinary symptoms of plumbism, such as cachexia, colic, arthralgia, with the blue line on the gums, and lead was found in the urine of all the samples tested by Leffmann. The following summary is in part verbatim:—

The saturnine cachexia was present in 78.21 per cent. (50) of the cases, while the remaining 14 exhibited a more or less sallow hue of skin. Emaciation was present in all who had been affected for several months. Pronounced neurasthenic symptoms, associated with the various phenomena denominated lead-cachexia, as well as

those symptoms indicative both of disordered primæ viæ and the specific action of the metal on the gastro-intestinal apparatus, in a large number antedated for a considerable period the development of marked symptoms of plumbism.

Colic was present in 76.56 per cent. (49), and 60.93 per cent. (39) exhibited all the phenomena of pronounced lead-colic. Frequent vomiting of a greenish-yellow or greenish hue was present in 79.68 per cent. (51) of the 64; it occurred particularly in those affected with colic, though it seems to have been a constant symptom in a minority in whom colic was totally absent. Though the symptoms of many of the 64 superficially suggested acute poisoning, it was ascertained by careful inquiry that all had shown prior to their supposed acute outbreak at least some slight indications of chronic poisoning.

Arthralgia, the pains of which were worse at night and totally unaccompanied by evidences of inflammation, was present in 73.43 per cent. (47), and affected most often and severely the flexor surfaces of the knees and ankles and the flexor muscles about these joints. Paralysis of the extensor muscles of the forearm occurred in only two cases. In both it was bilateral and complete. In three other cases slight ataxia of these muscles was present, but paralysis did not occur. Headache was present in 73.47 per cent. (47), in 43 of which it was so constant and severe as to indicate involvement of the deep cranial structures, although in many of these cases no other symptoms of encephalopathy appeared. Encephalopathy was present in 23.43 per cent. (15); in 17.18 per cent. (11) it was manifested as eclampsia; in 2 (3.12 per cent.) as delirium; in 1 as a modification of the delirious form, melancholia with accompanying hallucinations and delusions; and in 1 as coma. The eclamptic seizures were of epileptiform type, and were preceded in 10 of the 11 cases for days or weeks by other manifestations of saturninism, such as cachexia, colic, arthralgia, or severe continuous headache; and in at least 5 of these they occurred primarily during or immediately subsequent to an attack of colic and arthralgia. In at least 4 of the 10 excruciating cephalalgia preceded for several days their outbreak. The convulsions were in all general, severe, and in several violent. Their duration was longer than that of idiopathic epilepsy, the clonic stage often continuing upward of a half-hour, during which the tongue was known

to be bitten in at least 6. The intervals in the 8 fatal cases were exceedingly brief, the convulsions rapidly recurring until death took place in from eight hours to four days. In these, too, after the first few seizures consciousness was entirely lost and stupor or coma persisted until dissolution. In only 1 of the 11 was he able to discover that an aura preceded the convulsive attack. In this 1 it preceded only 3 spasms out of several. In 7 of the 11 he discovered the probable time existing between the first exposure and the appearance of the convulsions, during which lead was constantly injested. In one it was 15 days, 32 in another, and 33 in a third; 2$\frac{3}{4}$ months in a fourth, 4 months in a fifth, and 4$\frac{2}{3}$ months in a sixth; these were all members of one family. In a seventh it was about 2$\frac{1}{3}$ months. Histories of a number of these cases are given in this and a preceding paper, to which the reader is referred for details.

The gums of 89 per cent. (57) of the 64 showed the blue line, and it probably existed in 6 of the remaining 7. In these 57 it was seen in all stages of its development, from a number of bluish-black dots or a faint streak of like color limiting the margin of mucous membrane grasping the neck of a single tooth to a deep dyeing of the whole labial surface of much-retracted and hemorrhagic gums.

Of five women who exhibited symptoms of plumbism during gestation none aborted. All at full term gave birth to living children. 4 of these 5 infants had convulsions within 2 months after birth, in which 2 died.

The mortality in the 64 is 12.5 per cent., the 8 deaths being among the eclamptic cases, making a death-rate in the latter of 72.72 per cent.

In the viscera of all of the 5 fatal cases examined by Drs. Reese and Leffmann lead was found, and in 4 in notable quantities.

Lead chromate has hitherto been thought very slightly soluble in the intestinal juices. Recently Dr. Leffmann ascertained by experiment that it is freely soluble in very dilute solutions of ordinary household vegetable acids, in very dilute hydrochloric acid, and in solutions of hydrochloric acid and pepsin.

POISONING BY OPIUM.

Certain symptoms are apt to be found in every case of profound narcosis from opium in the adult, such as lividity of coun-

tenance, subnormal temperature, dry mouth and tongue, free perspiration, spasms more or less general, incontinence of urine, dyspnœa, and tracheal râles. In addition to these a case of Scheiber's[38] presented some unusual symptoms, due perhaps in part to her neurotic temperament. A woman, aged 54, took for severe neuralgia $\frac{9}{10}$ of a grain of morphine hypodermically. The narcosis lasted forty-eight hours, but for six weeks the patient exhibited aphasia, agraphia, alexia, entire amnesia with disturbances of mind, evinced by irritability, childishness, and illusions. She had at the same time a bed-sore on the buttock. The neuralgia disappeared along with the chief nervous symptoms after galvanization had been used for eight days. According to Scheiber the symptoms must be ascribed to the morphine and consequent cerebral hyperæmia and capillary apoplexy.

The absence of morphine from the urine of subjects poisoned by it need not raise a doubt of the fact of poisoning. According to Greene,[39] Julius Donath has not been able to find morphine in the urine of a morphio-maniac, who in forty-eight hours took one and a half grams (23 grains) of morphine hypodermically.

In another case, after an injection of thirty-six centigrammes ($5\frac{1}{2}$ grains) of morphine, sulphuric acid was sought in vain.

The least amount of morphine that could be detected after addition to the urine was two-tenths per thousand. Donath's process consisted in treating a litre of urine with a little hydrochloric acid and evaporating to one hundred and fifty cubic centimetres, precipitating with iodide of potassium and mercury and decomposing the precipitate in water acidulated with hydrochloric acid by hydrogen sulphide; the solution was concentrated, neutralized with ammonia, and evaporated to dryness, the residue extracted with hot alcohol, the extract evaporated to dryness, redissolved in hot water containing a little hydrochloric acid, and the solution allowed to stand twenty-four hours after neutralization with ammonia; the morphine then crystallizes.

Among the easily performed tests for morphine, the *Moniteur du Praticien* recommends the following as showing the presence of the alkaloid in quantities not less than 1–200 grain: To a solution of the suspected substance add a few drops of sulphuric acid and a few drops of solution of sodium sulphate. The mixture must then be heated in a porcelain crucible until sulphuric vapors

begin to appear. It is then cooled rapidly, and if morphine is present it will turn deep violet. If heated further the mixture becomes brown; then if cooled and moistened with a few drops of water it turns to a bright red. The addition of more water causes a change to pale green. If an equal bulk of chloroform be well shaken with this green liquid, the chloroform takes a bright-blue color.

Our knowledge of the histological changes induced by poisonous doses of morphine is as yet very incomplete. Pilliet[40] has lately made an experimental study of the lesions of subacute morphine poisoning. Having administered daily for a number of days 10 centigrammes of morphine to some dogs, he found in two instances lesions of the liver and the brain. In the liver there was fatty degeneration ranging from infiltration of the cells by fine drops to complete fatty transformation. The cells of the gall-bladder were fatty. There were no signs of embryonic proliferation in the brain. Sections of the convolutions were compared with corresponding regions removed from healthy dogs, and were found to present numerous tracks of granular bodies which penetrated into the substance of the brain, and simple atrophy or fatty degeneration which had destroyed numbers of the large cells.

On the whole these observations give very little definite information except to confirm the old view that the pathological effects of morphine are due to no specific lesion. Histological changes similar to those discovered by Pilliet have been produced in these organs by other alkaloids, and also by some mineral poisons.

In examining the medical periodicals of the past year atropine will be found to hold a prominent place among the agents credited with having cured different cases of opium-poisoning by physiological antagonism. The list includes one[41] relieved by amyl nitrite after belladonna had failed; one[42] that recovered under gelsemium and strychnia; two related by Stadler,[43] treated by strychnia; three reported by Porham[44] as treated by injections of sulphate of atropine, with two recoveries; one infant[45] recovering under atropia; one recovery[46] under atropine and apomorphine; two recoveries, Bremner,[47] under atropine; and one by McPherson,[48] under atropine. The reports of the benefits from atropine are not uniform. W. H. Thomson expresses the opinion that the cases in which the opium narcosis is

really dangerous are those in which belladonna and its alkaloid are useless, if not injurious. Lenhartz,[49] having failed with atropine in three cases, began to question its antagonism to morphine and the propriety of its administration.

To settle his doubts he made a series of experiments on dogs, beginning with a study of the natural history of opium-poisoning when fatal doses were given by injection to dogs. He found that the lethal dose of morphine sulphate per kilogram for dogs varied. In a number of cases the smallest fatal dose was 0.27 gm., but recovery took place in one instance after 0.46 gm. had been taken. A diminished frequency of the pulse and lowered blood-pressure were constant phenomena, whether the dose was large or small. The fatal cases succumbed to arrest of respiration, due to tetanic cramps. On the administration of atropine some of the symptoms were antagonized. There was instant dilatation of the pupils, quickening of the pulse, and an increase of blood-pressure. The two effects last named could be produced as well by cutting both vagi. In none of the experiments did atropine have any effect on the dangerous symptoms,—cramps or convulsions resembling those produced by strychnine. It did not prevent their occurrence, and hence he holds that its antagonism is limited and of no real value in the most serious cases.

Lenhartz, in considering the whole question again from a clinical standpoint,[50] has collected 132 cases of opium-poisoning, of which 59 were treated by belladonna or its alkaloid. Seventeen thus treated died, making a mortality of 28.8 per cent. Seventy-three cases were treated without belladonna or atropine, but in general by stimulants and cold baths. Eleven thus treated died,—a mortality of 15 per cent. By comparison of the mortality we learn that the method of treatment by atropine was less successful than by stimulants. It appears to injure by increasing the heart-depression already brought about by opium.

Careful analysis of the observations made of these cases leads him to the conclusions that the condition of the pulse in opium-poisoning is variable; acceleration is most often present; less frequently weakness and irregularity. Respiration is generally retarded; changing respiration, somewhat accelerated, is not uncommon. Convulsions are more common than generally supposed; they usually occur among adults. The condition of the pupil

agrees with the statement of Orfila, that in nineteen out of twenty cases contracted pupils were present. His important practical inferences have been stated as follows:—

The physiological antagonism between atropine and morphine is not established by a single authentic observation.

The use of atropine is not to be considered a means from which even an improvement in the symptoms of opium-poisoning may be expected.

The principle of antidoting a poison by the use of another poison like atropine results in unreliable dosage, which has been productive of great injury.

The circumstance that cures have followed the use of atropine does not prove the positive value of the method.

The prognosis of opium-poisoning depends upon the use or neglect of a rational, non-antidosage system of treatment.

The use of forced respiration through the incised treachea to tide a poisoned animal over the dangerous period until the opium was eliminated is not new. Lately it has been applied successfully to man, as in the case of Dr. Laenger, who was thus saved from suicide; and in a case related by Dr. Fell.[51] In Fell's case the trachea was opened for the introduction of a tube furnished with valves, through which air was forced into the lungs for over two hours, during which the power to affect natural respiratory movement was suspended. When forced respiration was begun the arterial blood flowing from the wound was of a dark, coffee color, indicating very imperfect aeration. While the mechanical respiration was in progress the blood plainly showed the restoration of oxygenation by the change to a bright red. At the same time movements in the limbs were noticed, but normal respiratory acts were not established for two hours and a half.

POISONING BY PHOSPHORUS.

In studying the effects of phosphorus on employés of match-factories, Dr. J. Ewing Mears[52] was led to conclude that necrosis of the jaw is a local expression of the constitutional condition produced by inhalation of the vapor of phosphorus and its introduction by minute particles transferred from the hands to the food. The quantities of the agent are so small that acute symptoms do not appear, but gradually there is induced a disintegration of the

red blood-corpuscles and fatty degeneration of the arterial coats. He found that this toxic condition preceded the jaw-disease, which did not supervene until after several years' exposure. Examination of the jaws of operatives who returned to work immediately after extraction of teeth showed immunity from attack in the periosteal tissue thus exposed. In one such case necrosis did not appear until three months after his factory labor had ceased. Dr. Mears thinks that the conditions under which experiments have been made on animals to prove the connection between the disease and direct exposure of the periosteal and perialveolar tissues, are not similar to those surrounding operatives in match-factories. The antidotal powers of turpentine-vapor seemed to him to be well established by his experience.

Dr. Kroenig has reported his experiments on young dogs slowly poisoned with phosphorus. The lesions produced consist of necrosis in the acini and hyaline degeneration of the liver-cells themselves, of the vessels, and even of the red blood-corpuscles.

In studying a case of phosphorus-poisoning Poleck (*Archiv der Pharmacie*) detected three months after death no free phosphorus, but phosphorous acid was found in the contents of the stomach and intestines, and in the heart, liver, kidneys, and brain.

It would appear that in fatal acute poisoning by phosphorus the gastric juice is not materially altered; the pepsin and hydrochloric acid are formed as in health.

A poisonous dose of phosphorus was given to a dog,[53] and when toxic symptoms had fully developed a draught containing pepper was introduced into the stomach. The dog was bled to death, and although the glands of the mucous membrane were found in fatty degeneration the gastric contents were not unhealthy. A similar result was obtained from another dog, which six days after the poison was given had decided icterus and fatty degeneration of the stomach and liver. Peptone and pepsin were found in both stomachs.

POISONING BY POTASSIUM BROMIDE.

The symptoms due to continued use of any one of the alkaline bromides, and known as Bromism, are of daily occurrence, but death fairly attributable to this cause is very rare. Eigner[54] reports such a case in a woman 19 years of age, under treatment for epilepsy. Without medical advice she had by increasing doses reached

the amount of two tea-spoonfuls a day, which had been continued for several weeks. It was estimated that in less than a year nearly five pounds had been taken. The patient became weak, nervous, wakeful, slow of speech, and complained of vertigo, headache, and loss of memory. There was salivation, inflammation of mucous lining of nose and gums, and fetid breath. She staggered in walking; all her movements with the hands were tremulous. She became delirious and died in five days.

At the autopsy no lesion of the cerebro-spinal system was discovered, but there was a decided lobular pneumonia of the lower lobe of the right lung. It remains a question whether the pneumonia was not a necessary factor in causing death.

POISONING BY POTASSIUM CHLORATE.

When chlorate of potassium is given in poisonous doses gastro-intestinal symptoms are produced, accompanied by congestion of the spleen and liver. There are vomiting, abdominal pain, and loss of appetite. The urine is scanty and albuminous, and sometimes delirium, coma, and convulsions supervene.

Willie[55] lately observed a case that had taken 50 grams (771 grains) daily for a month. The following symptoms were caused: Vomiting, profuse diarrhœa, dyspnœa, weak heart, and cyanosis. The blood changed in color till it resembled chocolate. We may account for this change by the view of Marchand,[56] that the chlorate is reduced by the blood, hæmoglobin being oxidized to methæmoglobin, and death following as the result of the altered blood and the disintegration of the corpuscles. On the other hand, the gastro-intestinal symptoms suggest the opposing theory of Stokvis,[57] namely, that potassium chlorate destroys life, not by direct oxidizing and disintegrating action on the blood, but partly by gastro-enteritis such as follows the administration of all concentrated saline solutions, and partly by the physiological effects produced by it in common with other potassium salts.

Stokvis, alike with Kimmyser, has determined by a series of experiments that all of the chlorate taken appears unchanged in the urine except a small quantity accounted for by escape in the fæces, slow elimination, or experimental errors.

This appears to dispose of the theory of reduction of the chlorate, confirming the previous observations of Rabuteau and

von Mering. Stokris further denies that the chlorate affects the hæmoglobin in any way, and asserts that the formation of methæmoglobin is a putrefactive post-mortem change.

This latter view was recently attacked by Marchand[57] in an able and convincing paper which arrays much evidence against it. The cyanosis constantly seen denotes an ante-mortem change in the blood. Blood flowing from an artery of a living dog poisoned by potassium chlorate sometimes presents the brown methæmoglobin color. The blood-corpuscles can be seen in various stages of disintegration. The brown spleen-pulp shows masses of disintegrated and discolored corpuscles.

Both in man and in animals the kidneys present changes identical with those caused by hæmoglobinuria, while Stockvis holds that the tubules are blocked up with red corpuscles and albumen of hæmaturia. Marchand finds in the tubules the characteristic reddish-brown granular casts of hæmoglobinuria and methæmoglobinuria.

Toxic gastritis was observed by Marchand in but one case, and then it seemed to him a secondary and not a primary incident. With respect to the reduction of potassium chlorate, he does not argue with the same force or hold to his formerly expressed opinion with much tenacity. Friedländer has met with an acid reaction of the blood in several cases of this kind; and Riess[58] offers the suggestion that the blood changes may be due to lessened alkalinity brought about by the chlorate.

Lenhartz[59] supports Marchand in a record of a case under his observations, which died with uræmic symptoms. There was anuria, and the post-mortem appearances denoted a blocking up of the tubules by excreted hæmoglobin and methæmoglobin masses.

POISONING BY POTASSIUM IODIDE.

Cases of death from the use of this substance are happily rare. In addition to the one reported a few years ago by Morrow, another has been put on record by Wolf.[60] At the outset it must be stated that the patient was suffering at the time from renal disease and cardiac hypertrophy. This may go far in accounting for her unusual susceptibility.

The patient, a woman aged forty-eight years, took of a sample, afterwards proven to be chemically pure, six grains four times

daily. After four doses the face swelled and an acne and a pemphigoid eruption appeared, although the medicine was now stopped. In twenty-four hours this eruption involved the mucous membrane of the nose, mouth, throat, and larynx.

On the fourth day there was diarrhœa with stools moderately bloody. The blebs on the face, when broken, were succeeded by deep ulcers. In eight days the patient fell into collapse and died. No autopsy was made.

Some anomalies of distribution in the symptoms of iodism have been noted by Villar[61] and by Rice.[62] Villar's case was a man, aged 32, under treatment for a severe ulcer of the leg following a burn. Without a syphilitic history, he had enlarged axillary glands, scars on the neck left by former suppuration in the cervical glands, and an enlarged spleen. He had never taken iodide of potassium previously. Three grammes (46 grains) were given in two doses. In two hours after the last dose there came on sneezing, vomiting, depression, pain and swelling in the parotid glands, with headache.

The next day there were fever, facial eruptions and parotiditis on both sides. The symptoms disappeared rapidly, as the medicine was at once suspended.

The high degree of local mischief was probably due to his peculiar tendency to glandular inflammation.

The case reported by Rice is one of unilateral iodism, occurring in a plethoric elderly man, who had at one time previously some form of mental derangement. He took for a bronchitis three grains of the potassium iodide thrice daily. In thirty-six hours he developed great congestion of the vessels and swelling of the face, especially on the right side. The right ear was leeched to relieve the tension. Coryza was also present, most marked on the right side.

POISONING BY PTOMAINES.

Brouardel,[63] in the name of Ogier and Minorici, read before the Académie de Médécine a paper having as its subject the ptomaines as causes of error in toxicological research. The principal facts observed by them are as follows: 1. The liver and the kidneys furnish residues that have in general the same reactions. 2. The most abundant residues are furnished by amylic alcohol (alkaline solution), and by benzine and chloroform (acid solution). Petroleum takes nothing, or nearly nothing, away from alkaline solutions.

3. In one case only (a fœtus of seven to eight months, presenting no signs of putrefaction) the residues showed no alkaloid reaction. In all the other series more or less of basic substances were obtained, precipitated by general reagents (much the most sensitive of these reagents being iodide of potassium iodized). The residues are considerable from viscera in which putrefaction has hardly commenced (bodies of two to four days in summer); more abundant from viscera in active putrefaction (bodies of eight to twenty days); beyond a certain limit of putrefaction (bodies exhumed after two years or more) the quantity of ptomaines evidently diminishes conformably to the facts as observed by others. 4. The tabular results of these experiments show the amount of confidence that may be accorded colored reactions in the search for vegetable toxic bases and the influence of ptomaines on the reaction. For example, perchloride of iron has never given any coloration; it is therefore a good reagent for morphine. Alcoholic potash, after oxidation by nitric acid, never gave a violet reaction comparable to that of atropine. Nitric acid alone often gives yellow or orange coloration much less intense than that obtained with brucine, but capable of being confounded with the tint that would be given by a trace of morphine. The use of reagents containing a large excess of sulphuric acid (molybdate, vanadate, selenite, etc.) is rendered very uncertain by the presence of ptomaines; for mixed tints are obtained, reddish or inclining to violet, and very often identical with those given by sulphuric acid alone. With bichromate of potash and sulphuric acid, on one occasion only, a violet tint was obtained similar to that given by a trace of strychnine; with alcoholized sulphuric acid and perchloride of iron certain residues gave greenish tints, capable of being confounded with those of digitaline under similar circumstances. Without giving undue importance to these causes of error it is necessary to take them into consideration. The tints due to the presence of ptomaines are never as decided and as evident as similar tints produced by vegetable bases. Besides, one colored reaction does not suffice for a decided conclusion; it is necessary to consider the *ensemble* of the chemical and physiological facts, so that, in fact, the chances of error are very slight. The complete purification of the residues and the separation of the ptomaines are for toxicology problems of the highest importance.

When putrefaction sets in the first free ptomaine that appears is cholin, which in life exists only as a constituent of lecithin. It has been found also in hops and in ergot. It differs from neurin in composition by one molecule of H_2O, but neurin is far more poisonous. By means of Brieger's method for the separation of ptomaines Schulze[64] has succeeded in obtaining an alkaloid like cholin from lupin and pumpkin-seeds. Not only is its double-gold chloride similar to that of cholin in composition, but there is a resemblance in physical properties also, and in its behavior with the usual group reagents for alkaloids.

The same method of isolation for the ptomaines was practiced by Ehrenberg[64] in an investigation of sausages that had caused several deaths. Brieger's was found superior to Stas' process. When received the sausages had begun to decompose, and smelled of indol. No metallic poison was found. Then according to Brieger's method the finely divided material was digested in water fully acidulated with $H\,Cl$, filtered, evaporated, and extracted with alcohol. This solution was precipitated with mercuric chloride, the mercury thrown down by H_2S, and the dissolved chlorides precipitated as a double-platinum salt with $Pt\,Cl_4$. The organic bases detected were cholin, neuridin, trimethylamin, dimethylamin, and methylamin. Trimethylamin was most abundant, then dimethylamin and cholin. It may be possible that the fatal results were due to neurin—a powerful poison, but so unstable as to change by decomposition into the di- and trimethylamin.

The author ascribed the poisoning to the presence of all the products of putrefaction. The view of Brieger is that the very poisonous bases, such as neurin, are products of certain stages of decomposition, and that they are in turn decomposed by bacteria into the methylamins and other less poisonous compounds. On the other hand these salts of the substituted ammonias may be products of the action of $H\,Cl$ on the bases themselves, which are easily changed by the mineral acids.

Nauwerck made cultures of the bacteria of the suspected sausage on different tissues, with the result of finding no organic bases when blood was the material, but when liver, intestines, and other visceral structures were used they yielded to Brieger's process the same bases found in the sausage.

In a study of poisonous cheese, Vaughan[65] separated a crys-

talline substance producing a poisonous effect like that of the suspected cheese.

This he named tyrotoxicon, or cheese-poison. Extending his inquiry[66] he discovered the same principle in milk which had been kept too long. His method of isolating tyrotoxicon is as follows:—

Having filtered the coagulated milk, the filtrate was rendered slightly alkaline with potassium hydrate, and then agitated with ether. The ethereal layer was separated, filtered, and allowed to evaporate, leaving tyrotoxicon as a crystalline body with a marked odor and taste. Ten drops of a concentrated aqueous solution were given to a young dog and produced vomiting and diarrhœa.

Vaughan on a later occasion found the same poison in ice-cream that had affected eighteen persons. His latest studies, shared by Novie,[67] have resulted in the discovery that the tyrotoxicon makes a double salt with platinum chloride, which is explosive like the double salt of diazobenzol. Other chemical points of resemblance have been noted besides a similarity in physiological effect, and have led the author to suspect that tyrotoxicon and diazobenzol are one and the same thing. Some oysters suspected of poisoning have yielded the same reactions. It was observed that in a few days of decomposition the oysters lost their diazobenzol, which goes to show that this poison, like those studied by Brieger, is unstable, appearing at certain stages only.

POISONING BY SILVER.

Shallenberger[68] reports a case of skin-coloring from nitrate of silver.

The patient, aged forty, suffering from chronic diarrhœa, took one third of a grain three times daily according to a doctor's prescription for a few weeks, and then without further advice continued the pills for about two years. Her skin had a very marked dark metallic appearance in certain lights and a bright lustre in others.

Recent observations[69] made on 800 silver-workers in Berlin show that all had the coloration patches. These patches are round or oval in shape, varying in size from a millet-seed to a broad-bean. They are anæsthetic and occur principally on the dorsum of the left hand. Only workers in silver are thus affected. The absorption of the metal seems to have no effect on the general

health. Microscopical examination shows that the patches are caused by the deposit of metallic silver in the tissues. They are soluble in nitric acid and potassium cyanide. The men affected were invariably those who had some ulceration or abrasion of the hands through which the metal was absorbed.

Tolmatcheff[69] records a case of silver-poisoning from repeated cauterization. A strong peasant, aged 58, had a granuloma at the site of a nail-wound on the sole of his foot. After removal the denuded spot was cauterized with solid nitrate of silver and the application repeated fifteen times in two months, with supposed relief. On return of the granuloma seven months after he had the same treatment, including fifteen more silver cauterizations within two months and a half. About the end of that period the man began to lose flesh and strength. In a few weeks left hemiplegia came on, the face became of a leaden color, with ecchymoses under the eyelids; many brownish-black spots of the size of apple-pips appeared on the cheeks, forehead, neck, abdomen, hands, and feet; there was a bluish line on the gums; the sclerotics became discolored; the mouth was dry and had a bitter taste. Microscopical examination of a piece of the stained skin showed that the brownish-black specks were situated mainly in the lower strata of the Malpighian layer and in the upper ones of the subcutaneous cellular tissue. A month's treatment by tepid baths, iodide of potassium, and Glauber's salt did not effect any improvement. It was reckoned that the whole quantity of the silver salt employed in the case was not more than one drachm and a half.

POISONING BY STRYCHNIA.

We find a difficulty in reconciling the investigations of Chouppe with the observations of Henderson on any other basis than that strychnia and antipyrin affect man differently from animals. Chouppe[70] gave to the Société de Biologie his investigations tending to show an essential difference in the spasms as produced by strychnia from those produced by antipyrin. He found that the spasms due to antipyrin are much less tetanic than those due to strychnia; they are never excited by external irritation; they involve the respiratory muscles to a less extent; and never give rise to asphyxia. When a fatal dose of strychnia is injected into an animal which is under the influence of antipyrin, strychnine spasms

come on, which, however, after a fresh dose of antipyrin give way to antipyrin spasms; these latter last several hours without killing the animal. He concludes further that each of the two agents seems to weaken the action of the other.

Anrep[71] has found by experiment that urethan is antagonistic to strychnia. He thinks it superior to hydrate of chloral as an antidote to convulsive drugs. It is less dangerous and may be given in large doses with perfect safety. For man, doses of four to six grams (ʒj–ʒjss) would be required to overcome the poisonous effects of a lethal dose of strychnia. Bockal[72] asserts that in the dog paraldehyde is a powerful antidote to strychnia, though strychnia is not an antidote to paraldehyde.

It has been observed that strychnia, unlike brucia, can be precipitated from an aqueous solution of its sulphate by potassium ferrocyanide.

Holst and Beckurts[73] propose a volumetric method based upon this fact. They find that if a 0.5 to 1 per cent. solution of the two alkaloids, strongly acidified with hydrochloric acid, is treated with potassium ferrocyanide until a filtered portion of the solution gives a blue stain with ferric chloride paper, the whole of the strychnine is precipitated as acid strychnine ferrocyanide, whilst the brucine remains in solution. The amount of strychnine can thus be determined by using a standard solution of ferrocyanide, 244 parts potassium ferrocyanide corresponding to 334 parts of strychnine.

POISONING BY SULPHURIC ACID.

At the recent assizes at Liverpool[74] Elizabeth Berry was convicted of poisoning her daughter to procure insurance-money. The child suffered with gastric pain and vomiting of bloody matter. She had also red and blistered lips. The inside of the lips, the gums and tongue had a moist, white coating, which was not a fur of epithelium. In about three days the patient died, and at the post-mortem the whitish marks in the mouth were found changed to a dry, brown appearance indicating corrosive action. A black, charred patch was found in the œsophagus. The stomach was not charred, but both it and the small intestines gave signs of recent inflammation.

On chemical analysis of the various organs no poison was discovered. In spite of this the opinion prevailed that sulphuric acid

had been given. As is well known, this would be compatible with all the facts. Garnier lately investigated a case of undoubted sulphuric-acid-poisoning, and found a trace of arsenic commonly present in the commercial acid, but even from an alcoholic and ethereal extract of charred tissues obtained no reaction of sulphuric acid. The charred patches gave a strong acid reaction, which from further study Garnier concludes was due to phosphoric acid liberated from the normal phosphates of the tissues by the sulphuric acid. In Berlin, owing to the restrictions placed upon the sale of common poisons and the ease with which oil of vitriol can be purchased, this latter is of frequent use by the suicide. Mendelssohn[75] selects from the annual number a case for special mention. A girl of 25 took sulphuric acid in moderate amounts, and, surviving the immediate effects, showed symptoms of gastric ulcer, complicated with typhoid fever.

After four weeks a marked change for the better set in, but in the sixth week vomiting began again. As there was evidence of pyloric stenosis, resection was performed with a fatal result in twelve hours.

The mucous membrane was almost entirely destroyed, and the pylorus would allow only the smallest probe to pass.

POISONING BY TIN.

There is now sufficient evidence to show that tin compounds are poisonous locally and constitutionally. Having already proven experimentally that tin may be absorbed and afterward found in the tissues and urine, Ungar and Bodländer[76] lately investigated the influence of tin on the health. They used for their experiment frogs, rabbits, and dogs, introducing partly by the stomach and partly subcutaneously stannous chloride, the tartrate of tin and sodium, and the acetate of tin-triethyl. They found that even the non-corrosive salts of tin, when thus introduced, caused toxic symptoms ending in death. The results of repeating very small doses for some time were like those of other metals which gradually undermine the health, sometimes even causing death.

As the acetate of tin-triethyl was far the most poisonous, the conclusion is suggested that this compound acts as a whole, and not simply by virtue of the tin that is in it. The primary symptoms produced by it were peculiar, but quickly disappeared, to

be followed after some days by symptoms plainly due to the tin itself.

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LEGAL MEDICINE.

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THE LEGAL RIGHTS AND OBLIGATIONS OF MEDICAL MEN.

Professional Secrecy.—In Great Britain and in most of the States of this country, the law recognizes no obligation on the part of medical men to guard as sacred the information which is imparted to them in confidence by their patients. Practitioners of law are the only persons in these States who are not compelled to impart confidential communications, when the courts call for testimony under oath. In Arkansas, California, Indiana, Iowa, Michigan, Minnesota, Missouri, Montana, New York, Ohio and Wisconsin, physicians are permitted by statute to keep under their own control such facts of a medical nature as have been intrusted to them in the privacy of the sick room, but elsewhere in the United States physicians have no such privileges.[1]

In France, and in most continental countries, however, this state of things does not obtain. There, the medical man, instead of being punished for contempt of court if he persists in keeping inviolate his patient's confidences, is held accountable for just the opposite course; and the wise aphorism of Hippocrates that whatever information is acquired by the physician in, or even outside, the exercise of his profession should be regarded as an absolute secret, has passed from a tradition or custom into a statute law, with penalties attached to its infraction.

To this law, although the statute itself is absolute, there are some exceptions in practice, the medical practitioner being absolved by the judge from its provisions when he knows of plots against the state, or against the life or welfare of individuals; cases, for example, of poisoning, abuse of children, or criminal abortion. The general principle which governs these exceptions is that the first duty of a physician is to protect his patient, and if the patient is being poisoned, or, as a child, is ill-treated, the medical

attendant owes it to his patient to require the help of the law in preventing further damage. Prof. Brouardel[2] has very fully discussed this subject in a work which presents the matter from the point of view of French practitioners.

One of the immediate occasions for the discussions out of which this treatise grew, was the conduct and condemnation of one Dr. Wattelet, of Paris, who, fancying himself injured by certain reports which were in circulation, wrote a letter to a daily paper, explaining his conduct in relation to the patient, then dead, in the treatment of whom he was said to have erred; his letter contained allusions to the disease from which the deceased had suffered, and although there was nothing in the revelations of a nature to injure the feelings of his patient's family, he was prosecuted for violation of the code relating to professional secrets, and was fined one hundred francs.

This case illustrates the rigor with which the French law concerning medical secrecy is executed.

Prof. Brouardel discusses at considerable length the relation of medical men to life insurance companies, especially in connection with this subject of the disclosure of facts pertaining to the medical history of patients. The companies, as is well known, seek to obtain coveted information concerning the health of applicants for insurance, and after the death of insured persons they make a further raid upon the medical attendant's knowledge of his patient's personal history, by requiring among the proofs of death a certificate of the cause of the death.

The author approves the rule adopted by the Society of Legal Medicine of Paris, as follows: "Physicians should always absolutely refuse to give certificates indicating the nature of the disease to which their clients have succumbed; neither should they reveal any of the circumstances under which the death occurred." The company's interests are, or should be, sufficiently guarded by its medical examiner, whose duty it is to protect the company from imposition and from doubtful risks.

The subject of the obligation of medical men to keep professional secrets has engaged the attention of Italian physicians also; and at the last meeting of the Italian Medical Association, Prof. Guelfi[3] spoke forcibly on the subject, declaring that there are cases in which the physician is bound to preserve absolute secrecy,

even if he is summoned to testify in court, and even if he is freed from the obligation of secrecy by the parties interested; for example, in divorce suits for adultery with syphilitic infection by one or the other of the two persons contesting. There are other cases in which the attending physician ought not to keep silence; because in them the public social welfare is of greater moment than the individual interest; for example, an investigation relating to the health of a betrothed woman, or in epidemics, injuries by violence, cases of poisoning. In these cases the physician indeed should take the initiative in disclosing the facts. In short, according to Guelfi, medical liberty should be relaxed, and the limits of professional secrecy should be restricted.

In discussing the position taken by Guelfi, many members of the Association appeared to regard the question as a moral rather than a legal or professional one. Some, indeed, went so far as to call the obligation of medical secrecy an unjustifiable moral monstrosity, since it often serves to protect vice at the expense of innocent victims; others demanded for themselves and their fellows complete freedom of action under the guidance of conscience. The Association finally voted in favor of the retention of medical secrecy, and against the practice of giving information concerning corporal lesions.

There is another contingency in which professional confidence assumes important and sometimes embarrassing relations. Should a physician or surgeon give information to the police when a criminal comes under his care, and knowledge of the crime is obtained by the voluntary and confidential avowals of the patient? Upon this subject the *Medical and Surgical Reporter* remarks editorially that "as a rule physicians should religiously guard the secrets of their patients, and especially when to reveal them would expose the patients to shame or punishment. But this rule can not be strained so as to apply to the case of a murderous fugitive from justice. A man who breaks into the house of a keeper of other people's moneys, and makes an attempt upon his life in order to complete a felony, is an outlaw, and whatever pity a man or a physician might feel toward him should be counteracted by the pity he feels for every law-abiding citizen. When the consequences of his crime bring a dangerous criminal to the notice of a medical man, we hold it to be a duty that the latter should disclose the fact

to the proper authorities, and not hold back from any false notions in regard to professional confidences." Without question, this is the proper course to take.

The Physician's Rights as a Witness.—Mr. Abrams[4] of the Savannah, Georgia, bar has reviewed the law as it relates to the rights of the physician as an ordinary and expert witness, and the risks which he runs upon his refusal to testify. He says:—"A physician, as such, is under no obligation to the public to testify or give his opinion on a subject with which he is peculiarly conversant; because his profession, his skill and knowledge derived from study and experience, are essentially his own property, and no court can deprive him of them without just compensation. In this sense the license to practice medicine, surrounded as it is by numerous safeguards for the public welfare, with laws passed for its proper exercise, and punishments prescribed for their violation, may be termed a franchise, and his exclusive property.

"The conclusions from numerous adjudicated cases may be stated as follows:—First, a physician cannot be compelled to testify to matters and things, or give an opinion upon matters, derived from his professional skill and knowledge alone. Second, he can be punished for contempt in refusing to testify in a case where he has witnessed an act and is called on to prove it in a court of justice even though it involves professional opinions; the duty which he owes to the community in furtherance of public justice requires it."

The urgent need of some settled rules, statutory or other, which shall govern the employment of medical experts and establish their rights and privileges, is well illustrated in the following contrasted cases:—

"1. Dr. F. H. Darby, of Morrow, Ohio, was summoned by the State as an expert in a murder case. He refused to answer the following question unless paid a fee as an expert: 'State whether in wounds like this, there would be immediate gaping, or would the lips of the wound for a time remain in contact or nearly so.' The judge declined to grant the fee asked, because he held that there was no law for it, and Dr. Darby, for his refusal to reply, was sent to jail for contempt of court, and was released only after several days' confinement. He based his refusal on the ground that he was asked to give expert testimony, and as it was not

claimed that he had any personal knowledge of the case, the issue was a square one.[5]

"2. In the case of 'State of Michigan *vs.* Vanimmans,' the judge said, when a physician refused to testify on the ground that his testimony would be expert testimony:—'After many years' experience, study and observation, I decide that a physician's knowledge is his stock in trade, his capital, and we have no more right to take it without extra compensation than we have to take provisions from a grocer, without pay, to feed the jury. The court rules that the witness is not compelled to testify.'"[6]

SEXUAL INCAPACITY.

Hermaphrodism.—According to Brouardel,[7] a genuine hermaphrodite is a myth. Hermaphrodism, so far as it relates to the internal sexual organs, has been found; but its coexistence with the external attributes of both sexes is impossible. During the first six weeks of intra-uterine life the fœtus is both male and female; according to the prominence and development of the gland of Müller or the Wolffian body, it becomes male or female. It can be readily understood that if the development is parallel, it might result in the coincident formation of an ovary and a testicle which ordinarily remain in a rudimentary condition.

It is quite different with the external organs. During the first two or three months, determination of the sex of the fœtus is extremely difficult; one observes something like the rudiment of a penis, which is destined to become either a clitoris or a penis. The scrotum is cleft in the median line; the closure or non-closure of this cleft determines whether a true scrotum or a vulva shall be the result. But it is easy to understand that we cannot have at the same time in the same person closure and separation of the parts, a scrotum and labia majora. Complete hermaphrodism, therefore, cannot exist; we may find simply malformations capable of raising doubt as to the true sex.

With regard to hermaphrodism of the internal organs, Brouardel recognizes four chief varieties; we may find (1) two ovaries and two testicles, (2) two ovaries and one testicle, (3) one ovary and two testicles, and (4) one ovary and one testicle. Examples of any one of these varieties are extremely rare. To these should

be added a fifth and still rarer abnormality, in which the individual, a male, has two testicles and something like a uterus.

The cases which have a more immediate practical interest in their medico-legal relations are those of pseudo-hermaphrodism, which consists generally in an arrest of development of the sexual organs in the male, and in an excess of development in those of the female. Of the former, a typical example is hypospadia. The subjects of this deformity are usually cryptorchids. In the female, spurious hermaphrodism is found illustrated in an exaggerated development of the clitoris; to this is joined sometimes an obliteration of the vulva.

In hypospadia, the rudimentary penis shows at its base a groove, a kind of cutaneo-mucous frenum beneath it; this the author has never found upon the clitoris, and it is in his opinion an essential characteristic of the male sex. Then, on the other hand, the cleft scrotum of the hypospadian, showing in the two halves a resemblance to the labia majora, has nothing analogous to the labia minora; there is no case of a hypospadian with nymphæ or a hymen.

RAPE.

The Gonococcus and its Recognition.—The medical jurist often has to determine the true nature of a urethral or vulvo-vaginal discharge, and to be in a position to state whether the pus is or is not gonorrhœal. Lober,[8] of Lille, has undertaken a series of observations whose results are an essential aid to diagnosis. All fluid discharges from the parts mentioned contain micrococci, and pus especially displays several varieties of them. The one character which, according to Lober, distinguishes the specific gonococcus is the property which it possesses of decolorization when the staining method of Gram is employed.

Appreciating the difficulty of differentiating this microbe in the midst of a great number of others by the simple process of staining the specimen submitted for examination, Lober resorted to cultivation as a means of diagnosis. He tried cultivations in bouillon and in agar-agar, peptonized and sweetened. The latter gave good results. After having liquefied the agar-agar, previously sterilized in glass tubes, and having mixed with it the fluid to be examined, he spread the preparation on a glass plate, and placed it under a sterilized bell-glass.

The cultures were kept at a temperature of from 12° to 20° C. On the third day, there appeared as a uniform result, on the surface of the cultures of gonorrhœal pus, small white points, which the next day became spots of the size of a pin's head, and later spread more and more. If one colored these colonies with methyl violet, they were found to consist of various forms of micrococci and diplococci. Treated after the method of Gram and with alcohol, all the elements became decolorized. The results as described were uniform when gonorrhœal pus was used for the cultivations. Often, alongside these white colonies, there appeared yellow groups; these were colonies of staphylococci which retained their staining.

Lober was successful in colonizing and recognizing gonococci by the above method, derived from pus-stains found on the shirt of a man charged with rape, and on the chemise of his victim. Microscopic examination and staining of a macerated portion of the same spots confirmed the culture results, by detecting the presence of the gonococcus in the pus cells. When non-specific pus was used as the material for the culture-process, the micrococci, streptococci and staphylococci found in the colonies were not decolorized by the method of Gram.

In this connection may be quoted a remarkable legal decision in England.[9] The charge against the prisoner was on two accounts, one with having carnal knowledge of an imbecile woman, and the other for a "fraudulent assault" on the same woman, occasioning her actual bodily harm. The harm done consisted in the willful infection of the woman with syphilis. The prisoner was found guilty of both charges, and was sentenced to two years' imprisonment for the first, and five years for the second offense. The lesson of this singular trial is that a man knowing himself to be suffering at the time with gonorrhœa or syphilis, may be convicted and punished for illicit sexual connection with a woman.

Proofs of Rape.—In a lecture delivered at the School of Medicine in Paris, Brouardel[10] corrected some of the errors which have taken root relative to the crime of rape and its proofs. In approaching the study of rape, he says, the common notion is that one has to do with a struggle between a strong and vigorous young man and an attractive young woman. As a matter of fact the contrary is the truth. The man is generally old, intemperate and

enfeebled, and the girl is small, scrofulous, ugly and dirty. Nor should the assault be regarded as a brutal or violent one; it is commonly otherwise.

Brouardel defines rape as the introduction of the penis into the vaginal canal of a woman without her free consent, whether she be a virgin or not; the crime may be committed even upon a prostitute. A "crime against chastity" on the other hand is any unchaste action practiced on the genital organs without penetration with the penis; such an unlawful action is ordinarily committed between persons of opposite sex, but often as well between persons of the same sex, with or without violence.

The violence may consist either of physical or of moral force; under the latter, the woman, terrified, is unable to resist or to give or withhold her consent. Another illustration would be intercourse with a woman by a man falsely representing himself as her husband when she was too sleepy to detect the fraud. In the same category would come anæsthetic states and hypnotism. It is not necessary to the crime of rape that the act should be accompanied by the ejaculation of seminal fluid.

Rape, as a crime, is increasing in frequency in France, especially as it is observed in the person of young girls under 16, who supply six times as many victims as are found among adults.

Tardieu gives the following statistics of cases occurring under his observation:—

Girls under thirteen years,	485.
Girls between thirteen and fifteen,	90.
Young women from fifteen to twenty,	84.
Women over twenty years,	9.

The crime is most frequent in the month of May, the world over; why this is so, Brouardel does not undertake to explain.

The difficulties attending an investigation of a case of rape grow out of several conditions; among these are the shameful attempts at blackmail which certain women practice, using their little girls for the purpose by irritating their external genitals; then it frequently happens that mothers, misled by a perfectly innocent discharge which they discover about the vulva of the child, honestly believe that an indecent assault has been committed, and by threats of punishment frighten the child into lying and the making of false charges.

Errors are often committed by medical men, not only in interpreting wrongly the character of muco-purulent vaginal discharges, but in declaring the hymen to be absent when more careful examination would show its presence.

Finally, certain anatomical conditions about the vulva, which are congenital and are found in whole families, are occasionally a source of error. Dolbeau, for example, describes what he calls a vulvar canal, a *cul-de-sac*, or cavity, just above the fourchette, and ascribed by him to repeated indecent assaults; the penis, too large to penetrate into a vagina hardly of the size of a pen-holder, makes a false passage and establishes a sort of cavity below the ostium vaginæ. Brouardel says that this may be true, but sometimes such a malformation runs in families. He mentions in illustration the case of a little girl whose father was accused of the crime, and whose "vulvar canal" admitted the thumb. Brouardel was unwilling to rest the truth of the charge on this one sign, and on examination of a younger sister he found exactly the same malformation.

Can a Woman be Ravished without her knowledge during Hypnotic Sleep?—Brouardel believes this to be possible only under certain very favoring conditions.[11] If a man who is agreeable to the somnambulist offers suggestions to her which are acceptable or of an indifferent character and not offensive, she submits herself to them; but if the suggestions are revolting to her personal affections or her natural instincts, she opposes to them a resistance which is almost insuperable.

One may easily lead the hypnotized subject, for example, to sign a receipt for money; but if she has preserved her normal chaste instincts, anything opposed to those instincts will be sought in vain. But, on the contrary, if the sentiments and the acts offered by the magnetizer to his subject correspond with her own, she obeys readily his suggestions. In the great majority of cases, however, a woman does not recall in her waking state, what happened to her in the state of somnambulism or *vice versâ;* yet the same feelings affect her in both states.

The Identification of Spermatozoa in Cases of Rape.—Ungar[12] softens a small portion of the stained material in distilled water, to which he has added hydrochloric acid, in the proportion of one drop to forty c. c. of the water. This slight acidification seems to

retard the swelling and distortion of the zoösperms, and with no other disadvantage than that of shrivelling them a little, a matter remedied by using a higher power with the microscope. After the specimen has been stained, it is dried over an alcohol lamp. Ungar has succeeded in obtaining a double staining of the zoösperms by means either of eosine and hæmatoxylon, of carmine and eosine, vesuvine and eosine, or, more simply, by methyl green and hydrochloric acid.

SUFFOCATION.

On the Signs of Homicide by Suffocation.—Fauvelle[13] declares that medico-legally the signs of asphyxia by suffocation have relative importance only, all the interest in this relation attaching to the signs of violence which indicate a homicide, criminal or excusable. He states that, in twenty years' experience, he has made thirty-four investigations in cases of death by suffocation; in twenty of these, suffocation was the result of occlusion of the mouth and nose; seven times, pressure on the larynx and trachea was the cause; three times, death was caused by compression of the thorax and abdomen; and one was a case of living burial. In three instances, notwithstanding distinct signs of suffocation, the absence of violence forbade a conclusion that they were cases of homicide.

Suffocation is a kind of asphyxia in which a mechanical obstacle to the entrance of air into the lungs is the single lethal element. It is always marked by engorgement of the right cavities of the heart and great vessels leading to them with dark fluid blood, and the complete emptiness of the left cardiac cavities. Fauvelle believes that suspension of the respiration arrests the venous circulation. There results a plethora which distends the capillaries of the thoracic and abdominal organs, and produces capillary ruptures which appear in the form of minute superficial ecchymoses. The author regards subpleural punctate ecchymoses as of little value as an evidence of homicidal suffocation.

In cases of occlusion of the mouth and nose, the density of the tissues renders sanguineous extravasations in those parts very rare (one case in twenty). Most often, one finds a red discoloration, due to dilatation of the capillaries and exactly limited to the region subject to pressure. These signs of pressure are found not only on the nose and lips, but also on the mucous membrane of the gums.

The palm of the hand is used almost exclusively for pressure; hence traces of the nails are observed only on the eyelids, at the root of the nose, and in the region of the masseters. Twice only did Fauvelle find that the occlusion of mouth and nose had been accomplished with the aid of intermediary means; but the traces of pressure were not wanting, although they were more diffused and less defined.

BLOOD-STAINS AND THEIR IDENTIFICATION.

Recognizing the difficulties that attend the examination of blood-stains under the usual conditions,—the small amount and the dried and altered state of the blood,—M. Ferry de Bellone[14] treats the suspected stain as follows: If it is on linen or cotton cloth, he cuts it in straight strips, separates the threads with a needle and places them in a small glass tube with a solution of sodium chloride, one part to one thousand. After an interval of a few hours, longer or shorter according to the season and temperature, the liquid takes on a reddish-brown color, from the disintegration of the stains. The fluid thus colored can be at once subjected to spectroscopic examination by adjusting the axis of the tube as nearly as possible to the axis of the instrument; the presence of the two characteristic absorption bands near Frauenhofer's band indicates the presence of hæmoglobin.

This fact having been established,—and it is useful in giving information of the presence of blood without touching the liquid, —the next step is to search for blood-globules. The fibres of the fabric having been taken out of the tube, after first shaking it so as to detach the cell-elements and cause them to settle to the bottom of the liquid, one or two drops of a concentrated solution of chloral are added. This forms very quickly a red precipitate which seeks the bottom of the tube. When this precipitate is well settled, the clear supernatent liquid is withdrawn with a pipette, and a drop of the red residue is carried to a glass slide.

This slide is passed rapidly and repeatedly over the flame of an alcohol lamp; this produces a reddish coagulum, from which a clear liquid is separated, which should be absorbed and removed by means of blotting paper. There then remains upon the glass slide the coagulum only, in the form of a thin, delicate pellicle. This is stained red with a solution of fuchsine, and when the stain-

ing is completed, the pellicle is washed with water by the use of a pipette. Then a drop of dilute acetic acid is placed on the specimen, and it is covered with a covering glass. The preparation is now transparent, and the fuchsine fixes itself in the blood-globules, coloring them a bright red. The microscope now permits one at once to recognize the blood-globules and to differentiate their special forms and diameters. The blood of ducks and fowls, so treated, has shown the characteristic oval shape of the globules after several years.

When one has to manipulate blood-stains found on the blades of weapons, on a floor, on wood or on stones, the spot is scraped off and the powder so obtained is placed in a bag of fine cambric; the specimen is then suspended by a thread in a tube in the solution of sodium chloride. When the blood is mixed with soil, the separation of the globules is more difficult, because of the clay usually found, which settles rapidly in the saline solution. An attempt should in this case be made, with the help of a microscope of low power, to determine the particles which, by their color, resemble blood; and where these have been culled they may be treated first with the saline solution and then with the chloral. In this case, too, the reaction for crystals of hæmine or chlor-hydrate of hæmatine will be indicated, according to the usual method with glacial acetic acid; and its results will declare whether or not the substance is dried blood. The same reaction, as a control method, is applicable to all such investigations.

Lacour[15] formulates the following conclusions as the result of an extended series of careful studies in the same field of inquiry:—

1. In the majority of cases, where total decomposition has not occurred in the specimen, one can recognize the presence of blood in suspected stains, even after the lapse of several years, by using the method of micro-chemistry and spectroscopy.

2. If skill and care are employed, one can distinguish human blood from that of bullocks, sheep and oviparous animals. The search becomes much more delicate when one has to do with the blood of the dog or the rabbit, and a distinction between human blood and that of the guinea-pig is altogether impossible. The globules of other domestic animals resemble more or less those of the human subject in their diameter, but can all be differentiated.

3. One can certify that he finds in the specimen of blood

examined, blood-globules which in all respects are like those of man or the guinea-pig, when the average of his measurements gives a number above 1-127 of a millimetre; but if there be much variation from this average, it shows that they may have come from a dog or rabbit.

HANGING AND STRANGULATION.

A Cause of Instantaneous Death by Hanging.—Brown-Séquard,[16] having demonstrated experimentally that an incision in the neck, in front of the larynx, produces analgesia in all the adjacent parts, thus explaining the fact that suicides are able to make deep wounds in the neck that would seem to be incredible if the peripheral nerves of sensation retained their function, has carried his investigations further and has determined that the larynx and skin of the neck possess, when mechanically irritated, important inhibitory functions of great interest in the study of death by hanging.

Medical jurists, he states, know that dead bodies are sometimes found suspended, under conditions indicating that the suspension itself was incapable of completely cutting off the air from the lungs and thus causing death by asphyxia. An explanation of the mode of death in these cases is found, according to Brown-Séquard, in the fact that any mechanical irritation of the larynx, or of the trachea, or of the skin covering these parts (although the latter point is not established), can cause inhibition of the heart's action, of respiration, and of the functions of the brain.

Such irritation may bring about, all at once, complete loss of consciousness and a cardiac and respiratory syncope more or less complete. In this respect, there is a very strong analogy between the effects of a puncture of the medulla and those of a mechanical irritation of the larynx and trachea and of the skin overlying them. Brown-Séquard demonstrated that the parts which, if irritated, produced analgesia by inhibition were ranked as follows:—

1. The region supplied by the terminal filaments of the superior laryngeal nerves (the mucous membrane of the larynx).
2. In a less degree, the trunks of those nerves and the trunk of the vagus above the origin of the superior laryngeal.
3. The trachea, which sometimes, if ligated, causes a nearly complete though transitory analgesia.
4. The skin of the neck in front of the larynx.

WOUNDS.

Suicide by Penetrating Contused Wounds of the Head.—Suicide by contused wounds directed against the head are admitted by all medico-legal writers to be very rare. Dr. Allen Staples[18] gives abstracts of cases of this class reported by Langer,[19] Fourmet,[20] Angenstein,[20] von Biart,[21] Carpenter,[20] Schauenstein,[20] Fritsch,[20] Albert,[20] Fabrice,[20] Liman,[20] Otto,[20] Maschka,[20] Riembault,[20] Kupfer,[20] Zaggl,[20] Hofmann,[22] Krugelstein,[20] von Haumeder,[20] Howe,[25] and Frank;[20] and adds notes of an extraordinary example of the same kind, under his own observation.

A German stone-cutter, intemperate and much depressed, drove into his head two stone-chisels, each $8\frac{1}{4}$ inches long, $\frac{3}{8}$ of an inch in diameter, with a flattened point. He used a wooden mallet weighing $2\frac{3}{8}$ pounds, and fifteen indentations on its surface into which the edge of the chisel-heads fitted, indicated the number of blows. One of the chisels was driven through the head from right to left, entering in the right temporal region and emerging in the left in a nearly direct line, the point projecting an inch and a quarter; while the head of the tool was down close against the scalp. The other chisel was driven into the centre of the forehead and must have entered the frontal lobe of the brain at least half an inch.

It was found on inquiry that he drank heavily at a saloon adjoining his shop and then, at 9 A.M., returned to his shop, ostensibly to work. Twenty minutes later, two customers tried to enter the shop to consult him about some work; they found the door locked. Looking through the glazed part of the door, they saw the man coming toward them with a chisel protruding from his forehead. He stooped down and tried to unlock the door, but failed to find and turn the key. Those outside then forced the lock and entered.

His first words were: "Drive the chisels farther into my head." He added shortly after: "For God's sake, pull them out!" He walked a distance of forty feet with little aid, to a place where surgical assistance was given him. The chisels were withdrawn by traction with forceps with considerable difficulty. Moderate hemorrhage followed from the temporal wounds. The patient, at first semi-conscious, became comatose after the removal of the chisels; he was so restless as to require restraint. He sank gradually, and died at 2.30 P.M. on the day after his injuries.

In concluding the report of his case, Dr. Staples remarks: "A study of the above cases shows that death often does not result from the immediate effect of the injuries; more often, the patient either gets well of them, dies from the resulting inflammation, or tries some other method of suicide. Another lesson drawn from these cases is, that even heavy blows against the head do not necessarily produce concussion of the brain.

"In a given case the diagnosis between murder and suicide may be of great importance, and attention to the following points will be of use.

"1. The situation of the wounds must be one readily accessible to the hand. The majority of these injuries, as the cases given above attest, are situated on the frontal and parietal bones, more rarely on the temples, very rarely indeed upon the occipital bone.

"2. Usually more than one wound, frequently many, are found. It is easily comprehensible that the first blows are made somewhat cautiously, and being comparatively unimportant, do not render the suicide incapable of completing the act.

"3. The injuries are, as a rule, huddled together in a comparatively small space, and take a parallel course. This is easily explained by the quick motion that has been taken by the hand. This disposition of the wounds, almost characteristic, is one of the most constant and weighty signs to which our attention can be directed.

"4. Heavy, strong instruments are regularly used. If they are blunt, fewer wounds are to be looked for, as unconsciousness would be more quickly induced.

"5. In many of these cases, other injuries made with suicidal intent, or traces of them, can be found in other portions of the body.

"6. Signs of resistance, or non-resistance, should in every doubtful case be looked for. Regularity of the wounds and a grouping together of them, are not compatible with resistance.

"7. The history of the patient, as concerns the mental state, is always of importance. Most of these suicides had shown aberrations of intellect, perhaps of a transitory character, and hereditary taint came often into play. Delirium and cephalalgia were also the causes in one case each.

"It goes without saying, however, that to avoid an error of

diagnosis, all the circumstances in a given case must be carefully considered."

Suicide by a Penetrating Wound of the Heart.—This unusual method of suicide had an illustration in the case of a man, 77 years old, living in Clerkenwell, England, who made nine punctured wounds in the epigastrium and the regions immediately adjacent, using a darning needle made more easy of handling by means of a cross-piece of tin fastened securely in the eye. One of these punctures had penetrated through the fourth right intercostal space and had entered the right ventricle, wounding one of the posterior group of musculi papillares. Through the small puncture in the heart, blood to the amount of nearly a pint had escaped into the pericardium. Seven punctured wounds were found involving simply the anterior abdominal and thoracic walls. The ninth wound was the one in which the needle was found fixed post-mortem; the weapon had made a superficial laceration of the liver in this last puncture. The patient lived "an hour or more" after the wound of the heart.[24]

The Medico-legal Significance of More than One Mortal Wound on the Same Dead Body.—The Burton murder case, which occurred in October, 1885, in Newport, R.I., became the occasion for a discussion of the abstract question whether it is "possible for an individual, with suicidal intent, and in quick succession, to inflict a perforating shot of the head and another of the chest implicating the heart. Or, reversing the proposition, is it incredible that a person, bent on self-destruction, can, with his own hand, shoot himself in the heart and in the head?"

The cause of death in the case referred to was, at first, believed to be suicide; neighborhood rumors and suspicions aroused after the funeral of Burton led to a reconsideration of the affair and to a reversal of the previous decision of the coroner. The man's son-in-law and two daughters were accused of the homicide and in due time became defendants in a capital trial. In the course of this trial, the eldest daughter confessed her guilt and that of her husband and told her counsel that her husband was the guilty agent of her father's death, she and her sister being accomplices. This confession was subsequently confirmed by her husband's avowals.

Burton was found one morning lying dead on the floor of the room where, as it appeared, he was in the act of taking his break-

fast when he was shot. Just before this discovery, two pistol-shots had been heard in quick succession, and a sound, as of a heavy fall, between them. The body lay on its back, near the table, in an easy attitude. A revolver, of .22 calibre, was on the floor near the side of the body. The mouth contained food that had not been masticated, and a portion of this protruded from the mouth, "having just been bitten off."

There was a penetrating wound of the head, passing from the right to the left and from the front backward, entering the right parietal bone about two inches above and in front of the ear, and lodging in the posterior part of the left hemisphere. Another ball had penetrated the thorax and had passed through the left ventricle of the heart, entering at the base and emerging at the apex. The clothing over this wound was burned, but the hair near the wound in the right temple had no appearance of being singed.

Prof. Agnew considered the medico-legal questions involved in this case of sufficient importance to justify him in devoting an elaborate paper to their discussion.[25] He assumed at the outset "that it is possible for a shot-wound of the head and of the heart to be suicidal, and as to the precedence of injury, the head or the heart, it is not essential to the case." If the former order is taken, the shot in the head preceding the shot in the heart, we must suppose that the individual did not lose consciousness and did not suffer paralysis of the upper extremities as a result of the wound. Cases are cited in support of this hypothesis. The loss of consciousness in a given shot-wound of the brain, Prof. Agnew declares, "is not due to the mere passage of the missile through cerebral matter; you can thrust a finger, a trocar, or a knife into portions of the brain, without at all affecting either sensibility or consciousness. It is due generally either to fragments of bone carried before the vulnerating body and buried in the cerebrum; to some large vessel or sinus being opened, causing a profuse hemorrhage; or to transmitted vibrations resulting from the impact of the ball against the skull, thus causing a molecular disturbance of its contents and momentarily deranging the orderly operation of the intellect."

Regarding a paralysis which may follow a shot-wound of the head and so prevent a second suicidal wound in another part of the body, Prof. Agnew is of the opinion that "so long as the middle portion of the ascending frontal and corresponding portion

of the ascending parietal convolutions remain uninjured, the power to use the arms is retained; and the same may be affirmed of the lower extremities, so long as the upper end of the ascending parietal convolutions, and that part of the posterior parietal lobule immediately behind remain intact. The motor centres are all grouped around the fissure of Rolando, and unless a shot or other missile trenches on these special regions, motility remains, though it may, after a time, be lost by extension of hemorrhage or from inflammatory products; and the fact that a man falls, or is unable to rise, after a perforating shot-wound of the skull, does not prove that the power to use his arms is lost; the missile may damage the leg-centres and not affect the arm-centres."

If the order of the shots is changed, and we suppose the heart to receive the first wound, and the head the second wound, Prof. Agnew is equally clear that the theory of suicide under such conditions may be maintained; he finds on record a considerable number of cases to support this view and to serve as exceptions to the rule that wounds of the heart are immediately fatal. He asks the question, after relating instances of survival, more or less prolonged, after penetrating wounds of the heart, "can any one doubt that in the most of the cases cited, these patients, had they been so disposed, could have inflicted a shot-wound of the head?"

Finally, he finds that instances have actually occurred illustrating the statement that a suicide can inflict the two wounds under discussion.

1. A student shot himself in a water-closet. The ball entered the head. Finding that he had not accomplished the work of self-destruction, he went to his bedroom along a passage and shot himself in the heart.

2. A policeman shot himself, first, through the head. The ball, entering the right temple, was found lodged in the cranial vault on the opposite side. A second shot was fired into his chest, the bullet entering the right side of the heart. Death from internal hæmorrhage followed in about five minutes. This was done in the presence of witnesses.

3. A boy, aged nineteen, inflicted four shot-wounds from a revolver on his own person. The first bullet entered the forehead and after taking a circuitous route, lodged about the middle of the left temporal lobe. A second ball was fired into the chest, and

passing through the sternum, it cut through the left ventricle of the heart, on a level with the mitral valve. A third shot passed into the abdomen, and the fourth into the neck. Death ensued from pericardial hemorrhage.

4. A grocer was found dead in his room, having locked the door. A pistol was still clutched in each hand. One bullet had passed through the brain, and a second through his heart.

5. A man committed suicide in a park; one bullet entered the brain and a second the chest.

Prof. Agnew draws the following conclusions from his observations:—

"1st. That it is possible for a ball to enter the brain without destroying consciousness, though it may for a few moments cause some mental confusion. 2d. That a ball might traverse the brain without causing muscular paralysis. 3d. That a suicide may, with his own hands, if so disposed, first shoot himself in the head, and within the lapse of a minute inflict a similar wound on the heart, and that there are a sufficient number of cases on record to establish the feasibility of the self-infliction of the two shots. 4th. That a suicide may first discharge a ball into the chest, wounding the heart, and immediately after send a second ball into the brain."

Dr. Thornton Parker, writing of this case, with a full knowledge of all the evidence, concludes thus:—[26] "The records of the Surgeon-general's office and the experience of surgeons prove beyond a doubt that the usual result of a severe penetrating bullet-wound of the head is a certain amount of immediate unconsciousness, evinced usually by a fall. The remarkable exceptions are not to be used as evidence to support the theory of suicide. The burden of proof rests with the advocates of the theory. The State should not be put on trial to defend a position so reasonable, but the defence must prove that the reception of a penetrating bullet-wound of the skull and contents is not necessarily followed by unconsciousness. The overwhelming evidence of the past fifty years of surgical history demonstrates to the unbiased observer that Mr. Burton could not have inflicted upon himself the wounds which destroyed his life. Such evidence cannot be gainsaid or resisted, and how it can be answered differently it is hard for me to understand.

"It was claimed by the defence that suicides very commonly

select the head as a target for the suicidal shot. However much truth there may be in this statement, it must be equally true that when such a wound is inflicted, powder-stains or burning must necessarily follow; but the main objection to the argument in connection with the Burton case is, that *immediately* after accomplishing this penetrating pistol-ball wound of the brain, the supposed suicide was able to accurately place, hold in position, and discharge, for the second time, the pistol, sending the ball into the heart. This is, in all human reason, an impossibility, and not one case can be brought forward to illustrate this extraordinary theory.

"The question of the amount of time, after the receipt of a wound in the brain, before unconsciousness would ensue, has provoked very much discussion. It seems to me that in ninety-nine cases in a hundred there is more or less shock varying from slight bewilderment and loss of reasoning to absolute loss of sense."

In further illustration of the same topic, the following case, reported by Dr. G. G. Hubbard,[27] may properly be added:—

A farmer, aged twenty-nine, prosperous, with pleasant environment, was found dead by his wife in his barn, lying on his back on the floor. His own revolver lay within reach of his right hand. It was of twenty-two calibre, and five-barreled; three chambers of it contained empty shells, the others were loaded. There were three bullet-wounds on his body; two of them were in the cardiac region, and the clothing surrounding them was scorched and powder-burnt, indicating a very short range. The autopsy showed that one of the bullets had entered the cavity of the right ventricle of the heart; the other one had not touched the heart. The third bullet had entered the right temple and had penetrated the brain at least four inches. This one had evidently been shot last, and the wound was also powder-burnt.

Undoubtedly Prof. Agnew's position is correct if the abstract question of possibilities is alone regarded. Each case, however, should be judged on its own merits. In the Burton affair, the experts for the State, (and of these the writer had the privilege of being one), had before them something more than a hypothetical case of possibilities; the data, as they were presented in the questions submitted to them in court, clearly indicated that, assuming the facts, as stated, to be true, the death was by homicide and not by suicide.

Punctured Wounds.—Katayama,[28] has made some observations upon the appearances presented by wounds produced by a conical pointed weapon upon the following organs and regions:—the skull of new born children, the tongue, the trachea, the aorta, the liver, the kidney, the bladder, the urethra, the uterus and the vagina. These general conclusions may be drawn from his studies:—

Punctured wounds made with conical pointed instruments, upon tissues and organs within the interior of the body never present a rounded outline; most often they are in the form of clefts or rents, rarely they are triangular or irregularly stellate. In the majority of the tissues and organs, these wounds have a nearly uniform appearance; the direction of the rents corresponds always to the natural direction of the fibres of connective tissue or of the muscles. In this respect, much depends on the state of the organs,—whether they are normal or diseased.

The work of Katayama is plentifully illustrated with figures which give a much better idea of these interesting studies than text-description can do.

INSANITY IN ITS MEDICO-LEGAL RELATIONS.

The professions of law and medicine make slow progress in coming to a common understanding of a definition and of tests of insanity which, while being scientifically accurate and acceptable, shall prove useful in the settlement of disputed questions affecting human life and the ownership of property. The legal mind is apparently unable to escape from the trammels of tradition, and cannot assimilate the advanced and constantly progressive ideas which are the fruit of scientific study, and result from a more humane consideration of the true relation of mental disease to pathology in general.

How wide apart are the ideas which prevail in the professions of law and medicine may be best understood by comparing the views of various writers or by watching the progress of an important trial where issues relating to insanity are raised, and able counsel and experts are employed. Meanwhile, recent medical literature has not been without evidence that the subject of the medico-legal relations of insanity has retained much of its former fascination; and if the views of medical writers still show some

diversity in details, they yet demonstrate the fact that, in general, there is substantial agreement upon the main question.

Of interest in this connection, is an article on the diagnosis of pyromania by Marandon de Montjil.[29] Discussing the medico-legal relations of this form of insanity, he defines its subjects as those who are urged on to commit the crime of incendiarism by an irresistible intermittent impulse. When arrested, they deny all knowledge of the crime, and their persistent lying is one of the main features of their mental state and the chief obstacle to a diagnosis of that state at the time the crime was committed. The writer summarizes his views as follows:—

1. There exists a mental disease characterized essentially, if not wholly, by an irresistible impulse to incendiarism, which seems to spring spontaneously from a profound unconsciousness of wrong-doing.

2. In a very large number of cases, the diagnosis of this disease is impossible by means of direct inquiry, either because of the dissimulation practiced by the accused or because of their intellectual feebleness, which does not permit them to supply needed information with regard to their mental state at the moment of the crime.

3. In these cases the diagnosis can be determined by certain data drawn from an indirect inquiry.

4. These data relate to the crime on the one side and to the criminal on the other.

5. The data pertaining to the crime are as follows, in the order of their relative importance:—(*a*) the fires are set in materials which are very inflammable and which need only to be touched with a lighted match; (*b*) they are multiple; (*c*) they are in the country; (*d*) they occur on Sundays and holidays.

6. The data pertaining to the accused are as follows: (*a*) absence of motive; (*b*) intellectual feebleness; (*c*) physical disorders and mental changes coincident with the crimes or immediately anterior to them (cephalalgia, palpitation of the heart, suffocative sensations, lassitude, general debility, taciturnity, despondency, a habit of making fires); (*d*) personal antecedents (convulsions in infancy, development of intellectual disorders, neuroses, fevers); (*e*) an inherited nervous disposition; (*f*) puberty, menopause or menstrual irregularities occurring at or near the time of the crimes; (*g*) eagerness to lend help in extinguishing fires;

(*h*) premeditation and slyness in executing the crimes; lying or equivocation during the examination; (*i*) a sound mental condition according to the belief of the community; (*j*) a habitation in the country.

7. The data relative to the accused are of more importance than those relating to the crime.

8. It is very rare to find all the conditions enumerated personified in a single individual; each case must be judged upon its own merits.

9. But the absence of motive ought always to be made out; this alone does not suffice to establish pyromania, but this mental disorder is incompatible with the existence of any motive, however trivial.

Partial Responsibility of the Insane.—Upon the occasion of a medico-legal inquiry into the mental condition of a woman who poisoned her mistress and concealed her body and later committed a series of ingenious frauds to obtain possession of her victim's fortune, Dr. Ball[30] raised anew the question whether insane persons should not be punished for such unlawful acts as do not flow as a natural consequence from their delusions: "thus, the lunatic who imagines his body is made of glass is decidedly insane; but if he murders a man whom he has good reasons to wish out of the way, taking artful and well-planned precautions, it is clear that he has reasoned in the same way as ordinary criminals and deserves to suffer the consequences of his acts."

The author believes that the deterrent effect of punishment, the only effect which justifies it, would be felt in a salutary way by a certain class of lunatics. Fear exercises an incontestable influence upon some deranged minds, and there is no valid reason why they should be exempt from penalties in proportion to their accountability.

In the case which was the occasion of Ball's comments, the culprit was a woman, clever at business, an indefatigable worker and of superior ability, who might be visited with religious visions and delusions, without losing a line of her intellectual advantages. Cupidity, her ruling passion, was the motive of her crime, and the ingenious precautions which she took to secure against discovery showed that she correctly appreciated and justly feared the consequences. The motives which governed her conduct are the same

as those which influence ordinary criminals, and the kind of insanity which she inherited does not in any fashion justify an exception in her favor.

This view was confirmed by the verdict of the jury. Ball observes that there are lunatics who, though they have imperfect ideas upon right and wrong, have, at least, a very clear perception of the dangers to which they expose themselves in breaking the law.

FŒTICIDE AND INFANTICIDE.

The Ethics of Induced Abortion.—Dr. James E. Kelley[31] argues forcibly that the readiness with which physicians resort to operative procedures to induce abortions under conditions which, it is assumed, place the mother's life in jeopardy if pregnancy is permitted to continue, is a blight upon modern civilization and professional honor. He pleads for the rights of the unborn child. He says:—"As physiologists, we cannot accept the dictum of Aristotle, who held that the fœtus did not attain viability until the fortieth day after fruitful coition; neither can we coincide with those legal authorities who hold that the human offspring is not a human being until it ceases to be *pars viscerum matris*, and is completely extruded from the body of the mother. From the instant at which impregnation occurs and the ovum receives life, the fœtus is human, and at all periods differs in degree only, and not in kind, from the infant and the adult. Therefore, we must regard it as a 'human being' with an inalienable right to life, and its destruction is homicide."

Homicide is either justifiable, excusable, or felonious, according to the circumstances attending it. To which class of homicide does fœticide belong? It is not justifiable homicide, nor is it excusable homicide or manslaughter. The very nature of the case demands grave premeditation and a definite plan of action, which constitute malice aforethought, with the obvious intention to commit a felony; and the operator has a perfect knowledge of the fatal nature of the act. Thus presenting all the essential conditions, we must look upon abortion as nothing less than willful murder, and in the class of unnatural crimes because it is contrary to the great fundamental and natural instincts of self-preservation and reproduction of species.

It is often contended that the undeveloped condition of the

fœtus and its dependent and defenceless state detract from its claim to existence; but this is an argument which, with equal propriety, may be advanced against the rights of many adults, most children and all infants. Mental deficiency might be pleaded with equal justice in defence of the murder of many of our fellow-creatures, as the imbecile, the insane, and even the comatose; but, far from extenuating the act, their condition only aggravates any violence which is offered to them; while monsters, the cyanotic, and the victims of arrested development could be as justly destroyed on the ground of incomplete physical conformation as the immature fœtus.

Another defence of abortion is based upon the comparison of the relative value of the lives of the mother and fœtus. This is but an effort to contrast the known with the unknown; for the natural development of this unborn being may result in a career greater than any with which the world has ever yet been blessed.

The relations of the child to the fœticide being thus formulated, how does the physician stand, who must act either as a skilled agent or as a principal in the affair?

In general, the duty of the physician in all cases may be summarized thus:—He must perform every just and lawful act which is essential to the life and conducive to the physical welfare of the patient whose care he has undertaken. In the act of abortion he performs an operation which is necessarily destructive of one human life, and, owing to its hazardous nature, most dangerous to another; and possibly, as in cases of multiple conception, the operation may result in the death of three or even a greater number of human beings. He voluntarily undertakes a deed sanctioned by no law, but always regarded as a felony. He constitutes himself the judge of a court from which time admits of no appeal; he ignores that impartiality so essential in an arbiter of life and death, and is simultaneously the judge and counsel for the prosecution; he decides adversely to the accused, and condemns him to death, and, lastly, is the executioner of his own sentence.

The prevalence of abortion as an established procedure in modern medicine shows that new laws are needed which shall tend to limit its application to the minimum and to alleviate, in the judicial sense at least, the act of abortion into "justifiable fœticide." Such a restriction, while affording every advantage, com-

patible with justice, to the mother, should insure to the fœtus every possible security by adequate investigation and representation, in accordance with established legal procedure.

Every court or tribunal consists of three essential elements: the plaintiff, the defendant, and the judge. The two first-named are frequently permitted to appear by proxy, and generally their interests are guarded by skilled advocates. In criminal law, where a fourth element is introduced in the person of the executioner, the greatest precautions are exercised to secure for even the most notorious malefactor every advantage which can accrue from a thorough investigation, the admission of favorable testimony, and the assistance of able lawyers, who are frequently supplied by the State. If such care be bestowed upon the equitable trial of abandoned criminals, it is natural to inquire if the State does not neglect its duty by permitting this notorious and daily destruction of human life without a rigid investigation, and the assertion of its unquestionable right to veto or to sanction each case, according to its merits.

If the authorities could be awakened to the necessity of establishing a tribunal for the purpose of restraining those practitioners who are not deterred by ethical considerations or religious scruples, its construction should be an easy matter for the practical legislator. According to precedent, it might consist of a presiding officer or judge, a physician of the highest professional probity and judicial reputation, an able practitioner as the counsel of the fœtus, the parent being represented by her personal medical attendant; the fourth member of the court would be the executive officer. That such an officer as a State-abortionist should be appointed is apparent, owing to the many instances in which no power could compel the attending physician to perform so repugnant an operation, while, even if he were to undertake it, his opportunities might not afford him the essential skill and experience. It would hardly be in keeeping with that rigid impartiality so desirable in a presiding officer if, as the executioner of his own mandate, he were to perform an operation for which he would necessarily be remunerated, neither would it be in keeping with the function of the physician, to whom we have alluded as the representative or defender of the fœtus, to destroy the life of his client.

With such a tribunal, the operation would be shorn of some of its most objectionable features. A restraint would be imposed upon those who regard their personal judgment as all-sufficient and final, if the practitioner were compelled to report to the executive those cases in which he considered abortion essential. The members of the noblest profession would be protected from a degrading demand to commit a felony; the popular opinion, which ascribes to the medical profession the odium of encouraging abortion, owing to the levity with which physicians frequently discuss the subject, would be exploded; without the sacrifice of dignity or emolument, the physician would transfer to the strong arm of the law a great responsibility; without any infringement of her liberty, the patient would have the advantage of supervision and treatment by skillful and experienced physicians in consultation with her own attendant; and, finally, two classes of criminal abortion, which occur but too often, and without attempt at concealment, would be eliminated. The first of these is that in which the patient, anxious to evade the trials of maternity, imposes upon the inexperienced or careless physician by simulating the alarming symptoms of pernicious pregnancy, until he is persuaded that abortion alone can preserve her life. In the other class, the practitioner, more or less above suspicion, justifies or cloaks a criminal abortion by averring that the evacuation of the womb is essential.

In somewhat the same tone, Dr. Isaac N. Quimby[32] discusses the anomalous state of the law relating to the destruction of fœtal life. Infanticide, in common law, consists in the doing of any act whereby the death of an infant is caused after it is fully born alive. It is distinguished, by law, from the killing of a child within its mother's womb, which is known as fœticide. When the death of a newly born infant is occasioned by an unlawful act, as distinguished from mere accident or unavoidable casualty, such an act constitutes the crime of felonious homicide and may be either murder or manslaughter, according to the circumstances of the particular case. In every instance, however, the death must occur after the actual birth of the child, or no crime is committed. If a person uses means for the procurement of an abortion upon the mother, either by the administration of medicines or by the use of instruments, or in any other way whatever, and the fœtus is destroyed before birth, the act is neither murder nor manslaughter,

at common law, but only a misdemeanor! It is not indictable, under the common law, to procure an abortion with the consent of the woman unless she is quick with child; and "quick with child" is defined by the law to mean that the period has arrived when the life of the infant has commenced, a fallacy based upon an old English law, which no longer obtains, that the use of the term abortion, medically considered, is limited to the expulsion of the contents of the womb before the sixth month of gestation. But that law has long since been repealed; abortion under English laws now means the expulsion of the fœtus at any period of gestation and its procurement is reckoned a felony. This ancient, but now exploded theory, that life in the fœtus does not commence until the third or fourth month of gestation is founded upon ignorance and a misconception of facts, and is contrary to modern science. As physicians, we should insist most positively that the life of the fœtus begins at the moment of conception, and therefore the destruction of the fœtus, at any period of gestation, should constitute murder.

Ventilation of the Middle Ear of the New-born Child, as a Sign of Living Birth.—Gellé[33] thus states his views with regard to the significance of air in the tympanum of the new-born child as an indication that the child was born alive. All authors, he says, admit the existence of a gelatiniform plug (often modified by extravasation of blood or by suppuration) which fills the tympanic cavity, and they know that this cavity becomes empty at birth, so as to give access to the external air. How does this transition from fullness to vacuity take place? To what is the penetration of air due? It is due at once to the absorption of the tympanic mucous mass and the penetration of air by the efforts of deglutition and respiration at the moment that the child cries. Hemorrhage and suppuration of the tympanum prevent the disappearance of the altered plug, and so oppose an obstacle to the admission of the air; so that certain conditions in the ear itself hinder the ventilation of the middle ear of the new-born child. In these cases the mucous mass persists, and thus the medico-legal value of this condition in its relation to living birth is considerably modified. If the lungs are found expanded, the problem is solved; if the lungs remain in a fœtal state, or are putrefied, the presence of air in the tympanum can be referred to the effect of decomposition; in such cases, how-

ever, it is not air which one finds, but most often it is a liquid mass. When one finds a firm plug in the middle ear and at the same time a fœtal state of the lungs, the two conditions together have a very great value.

Examination of the Mouth and Pharynx of New-born Children in Suspected Infanticide.—Huber[34] calls attention to the necessity of a thorough examination of the mouth, pharynx and larynx in cases of suspected infanticide, and criticises adversely the methods usually adopted in making such examinations. He recommends the following procedure:—The usual section in the middle line over the sternum is prolonged through the soft parts of the under jaw, that is, through the chin and under lip. One blade of sharp-pointed scissors is passed immediately behind the alveolar process, in the middle line, from above downward, and the mandibula divided. The halves of the lower jaw can then be separated and thrown backward on each side, affording a complete view of the mouth and pharynx, without disturbing any foreign body that may be located there.

The tongue can be drawn either forward or to one side, as most convenient. The advantages claimed are: facility of execution, thoroughness of investigation, with minimum disturbance of the parts in relation to disfigurement of the cadaver.

HYPNOTISM AND CRIME.

During the past year the medico-legal relations of hypnotism have received renewed attention. To such a degree has interest in the subject been stimulated in France that the French Government deemed it a worthy theme for full investigation at public expense, and appointed a commission composed of magistrates and professors of mental and legal medicine, Prof. Brouardel among the latter.

Two of the questions investigated by this committee were as follows:—[35] 1. Can a person cause another, when in a state of hypnotism, to sign receipts for money not received? 2. Can a person, hypnotized, be forced, against his or her will, to execute a will in favor of any individual? The mode of experimentation was as follows: A young woman was hypnotized, first by pressure on a suggested hypnotic point and then by slight friction on the forehead. Brouardel then approached her and asked her if she

would accept a loan of fifty francs. At first she refused; but on the suggestion being forced upon her, she gradually weakened and finally consented to accept the offer. A stamped receipt was then drawn up with every possible legal precaution and the patient herself was quite anxious that there should be no mistake about it. She then signed it and Brouardel put it in his pocket, but did not offer to give her the money. She was then awakened and acknowledged that the receipt was signed by her, but could not remember under what circumstances she had been induced to sign it, or whether or not she had received the money. Legally, the receipt was entirely valid, and the holder of it could collect payment for the loan.

In the test of making a hypnotized subject execute a will, a young woman was placed in the hypnotic state and told that it was absolutely necessary for her to make her will at once and in favor of the speaker. She objected, saying she was too young to make preparations for death. After a discussion of ten minutes, she said that if she made a will, she wanted to give her property to her mother and other kindred; but after persistent persuasion, and reiteration of the suggestion that it was better to give everything to the one who was addressing her, she finally accepted the proposition and agreed to give him all her savings, her money and her jewelry. A day was appointed for the signing of the will, which a notary meanwhile was to write. It was suggested to her that she should say nothing of the matter to any one in the mean time and, if she was asked later whether she had acted with her free will and consent, that she should declare that she had not been forced to the act by any person. On the appointed day, it was noticed that the young woman was fidgety and nervous during the early morning; she said she had something to do, but could not remember what it was. When hypnotized, she remembered the promise; and when one of the bystanders was introduced as the notary, she immediately signed her will, giving all she possessed to the doctor. This was duly witnessed, and the lawyers of the commission asked her if she was acting with entire freedom, without having been urged to the act; she replied that she had done the act of her own volition, that she knew her family was poor but she preferred to give everything to Dr. B. She said that she felt obliged to do so, but could not tell the reason. When awakened, she repeated the same story.

M. Gilles de la Tourette has devoted an entire volume to a discussion of the medico-legal relations of hypnotism and a rehearsal of his observations thereon.[36] A pupil of Charcot and of Brouardel, his ability to treat this rather difficult theme is amply shown in his interesting book. He traces the history and development of the singular state called hypnotism from the days of Mesmer, the charlatan, to the recent date when Charcot undertook its study, in 1878, as a purely scientific question. He describes the phenomena of hypnotism and its allied conditions, catalepsy, lethargy, somnambulism. He is of the opinion that as aids to crime by suggestion these abnormal states are of extremely little use in real life, however startling some of the effects may be in the experimental laboratory. Rape is the only crime which, according to this author, has thus far been accomplished with the aid of hypnotism under the form of lethargy. The possibility of thought-transference is denied by the author.

Mesnet[37] used hypnotism in one extraordinary instance to serve the ends of justice by testing the mental state of a young man accused of stealing. This young man, nineteen years old, had been a somnambulist for two years, his attacks being frequent and prolonged. During one of these, he stole various articles, and was arrested. The history of his idiopathic somnambulism having been established, he was subjected by Mesnet to a series of experiments to demonstrate if, by means of hypnotism, artificial somnambulism, and the commission of crime by suggestion, while in that state, were possible. After various manifestations clearly proving induced hallucinations of sight and hearing while he was hypnotized, the young man was brought to himself and declared that he could recall nothing of what had just occurred. Again hypnotized, he showed a clear memory of all that had passed in his previous hypnotic state, the various hallucinations which had been created for him and the feelings which he had experienced in consequence of them.

On another occasion, Mesnet directed his hypnotized patient to steal, on the following day, at a given hour, the watch-chain of one of the hospital externes; having consented to do this, the young man was awakened. The next day, after the hospital-visit was finished, Mesnet was seated at a table with his assistants, including the externe previously indicated. The hypnotic patient,

who had been sent for, came in and took the seat on the right of the doctor, the externe being on the left. Presently, the patient, who hitherto had been in his normal state, bright and cheerful, became reticent, vacant, and passed into the hypnotic condition. His countenance, previously calm and impassive, showed now evident distress; his forehead was wrinkled; his eyes were suffused; his conjunctivæ were slightly injected; there were livid spots on his cheeks; his respiration was rapid.

He fixed his look on the watch-chain. He reached his hands toward it, but withdrew them. Then, with a quick movement, he removed the watch-chain guard from the vest button-hole, drew out the watch, and placed it in his trousers pocket. At the same moment he ran out of the room to the story below where he was found in a state of bewilderment by an attendant. Restored to his normal condition, he declared his entire inability to explain how he got possession of the watch which was found in his pocket and the implication that he was a thief provoked a succession of violent nervous manifestations more or less analogous to hypnotism, —lethargic collapse, catalepsy, ecstasy.

This observation of Mesnet raises the question whether one has the right to hypnotize an accused person or any person whatever for the purpose of obtaining during his sleep a confession of crime or an accusation against another. Brouardel denies absolutely the right of the expert to use admissions obtained during hypnotism, with a view to fixing the agency of a crime.[38] He would use these confessions, if at all, only when they are for the advantage of an innocent person falsely charged or suspected. He draws attention, also, to certain practical difficulties in this connection. He says that in order to establish the confession as probable, it would be necessary to repeat the hypnotism at the trial in court. Then, exactly what value would a declaration so obtained have after all? Could one give it full credit? To do so, would be going beyond what our present knowledge would justify. Besides, it would, in effect, be open to the objection, that it would be obtaining information by a sort of moral extortion analogous to the confessions drawn from the subjects of physical torture. Would not one be proceeding far beyond the voluntary avowals of the subject of the experiment? In a word, it would be a reprehensible trap, and one should not use such a method with-

out the formal direction so to do, issued by the proper judicial authorities.

In a lecture delivered before the Paris School of Medicine, Brouardel set forth very clearly the most recent views touching the phenomena of hypnotism and the process of producing them in favorable subjects.[39] The fact that blind persons have been hypnotized is proof that magnetic sleep results from fixing the attention upon an imaginary object. Lasègue has produced the effect by simply shutting the eyes with the finger tips applied to the lids. Broca, Verneuil and Follin have performed amputation while the patient was in hypnotic sleep; anæsthesia was produced so thoroughly that the patient did not awaken during the operation. There are certain females who have hypnotic zones, certain well-defined regions of the body pressure on which will induce sleep; for example the lobule of the ear, the left thumb, the region of the elbows,—so that it happens sometimes with these latter that a person taking them by the elbows puts them to sleep without their knowledge or consent.

So much for the hypnotizing process; the restoration to the normal state is another matter. Puységur, who for a long time was the high-priest of magnetism, rubbed the eyelids of his subjects to such a degree as to produce ecchymoses; to-day, all that is needed is to open the lids and to blow above them with the breath. The initiatory phenomena of the sleep consist in a drooping of the lids, then a convergence of the eyes, as they are directed upwards, then a motion of swallowing, two or three sighs,—and that is all. There are several steps or phases of hypnotic sleep. The first state is that of lethargy. The woman falls over all at once, absolutely inert; it is the picture of death, without cadaveric rigidity. There is anæsthesia and analgesia. But the phenomenon which enables one to detect simulation is this:—if one takes hold of any muscle whatever, it is attacked with hyperexcitability and it contracts; this contraction is controlled only by seizing the antagonistic muscles. In the same way, if the course of the facial nerve is touched with a pencil, all the muscles of the face contract.

When a woman is in a condition of lethargy, if her eyelids are forcibly opened she enters forthwith into the state of catalepsy. She retains then, like a mannikin, just the position in which she is placed. There is here, again, a test which distinguishes

true catalepsy from simulation. If the arm of the patient is extended, she will hold this position indefinitely or at least will change it very slowly, obeying the law of gravity; the dissembler will make efforts which betray themselves by an abnormal rhythm of the hand and after a little she will be bathed in perspiration. There is still another thing worthy of note. When one makes toward or before the woman any gesture whatever, her face immediately takes on an expression corresponding to the gesture; thus, if you hold out the hands toward her, she has the look of desiring to kiss her hand to you.

Next is the state of somnambulism, provoked by lightly rubbing the forehead of the cataleptic subject. In this state, the phenomena are wholly different from those just described. The will of the woman seems abolished to a certain degree and replaced by that of the hypnotizer who makes the patient do all, or nearly all, that he likes. She will be unable to recall anything that has transpired. She goes and comes like any person, with sharpened vision, her eyes hyperæsthetic, able to read in a dim light; she may even seem to be able to read with the eyes closed, only a very slight parting of the eyelids sufficing. There is an exaggerated muscular force so that she will push aside vigorously any one who obstructs her passage. Finally, the hyperæsthesia of all the nerves of sensation is such that one needs only to breathe upon the back of the hand to cause it to close quickly; and upon the palm to cause the contraction to cease.

Prof. William A. Hammond[40] considers hypnotism a condition of automatism in which acts are performed without the conscious volition of the subject. He would call the state *Syggignoscism*—the agreeing of one mind with another mind. In these cases of hypnotism the consciousness seems to be so altered that the individual is not aware of his identity. It is the condition of double consciousness; and this condition we are able to produce in certain individuals.

The proportion of persons who are fit subjects of experiments in this direction is about two in ten of males and about four in ten of females.

MISCELLANEOUS TOPICS.

The Legal Relations of Inebriety.—Clark Bell[41] defines clearly and succinctly existing law both civil and criminal, with relation

to inebriety. He lays down among others the following propositions:—

I. Civil Relations.—Intoxication is regarded by the common law, when complete and characterized by unconsciousness, as a species of insanity. Lord Coke's fourth manner of "non compos mentis" was, "4. By his own act as a drunkard." Delirium tremens, which results directly from habits of intoxication, is in law considered to be a form of insanity, and this has been repeatedly held by the courts. It has always been a well-settled rule of law that no person can make a contract binding upon himself while he is wholly deprived of his reason by intoxication. This would be true as to deeds, wills, instruments and obligations of every kind. This rule was not changed when the intoxication was not procured by the other party to the contract, but is voluntary on the part of the drunkard. By common law and by statute law an intoxicated person is thereby rendered incompetent as a witness.

In the marriage contract, which in some respects is treated on different grounds from all other contracts, the general rule has been, that if the party was so far intoxicated as not to understand the nature and consequences of the act, this would invalidate the contract. It has been held that habitual drunkenness, being established, is *primâ facie* evidence of the subject's incapacity to manage his affairs.

II. Criminal Relations.—That form of intoxication which results in the total or partial suspension of, or interference with, the normal exercise of brain function, is regarded at law as mental unsoundness and sometimes amounts to a species of insanity. It has been held by law to be voluntary madness, caused by the willful act of the drunkard, and the decisions have been uniform that where reason has been thus suspended, by the voluntary intoxication of a person otherwise sane, this condition does not relieve him from the consequences of his criminal acts, or more carefully stating it, from acts committed by him in violation of law, while in that state.

There are decisions which go to the length of holding that the law will not consider the degree of intoxication, whether partial, excessive or complete, and even that if the party was unconscious at the time the act was committed, such condition would not excuse

his act; and in some cases judges have gone so far as to instruct juries that intoxication is actually an aggravation of the unlawful act rather than an excuse.

But the better rule of law now undoubtedly is that if the person, at the moment of the commission of the act, was unconscious and incapable of reflection or memory, from intoxication, he could not be convicted. There must be motive and intention to constitute crime; and, in such case, the accused would be incapable, from intoxication, of acting from motive. The law assumes that he who, while sane, puts himself voluntarily into a condition in which he knows he cannot control his actions, must take the consequences of his acts, and that his intentions may be inferred. He who thus voluntarily places himself in such a position, and is sufficiently sane to conceive the perpetration of the crime, must be assumed to have contemplated its perpetration. As malice, in most cases, must be shown, or established, to complete the evidence of crime, it may be inferred from the nature of the act, how it was done, the provocation or its absence, and all the circumstances of the case. Voluntary intoxication, though amounting to a frenzy, has been held not to be a defense when a homicide was committed without provocation.

Delirium tremens, however, a condition which is the result of drink, and is remotely due to the voluntary act of the drunkard, has been held to be a defense for acts committed while in the frenzy, similar to the defense of insanity. It has been held that when inebriety develops into a fixed and well-defined mental disease, this relieves from responsibility in criminal cases, and such cases will be regarded and treated as cases of insanity. It may now be regarded as a settled rule that evidence of intoxication is always admissible, to explain the conduct and intent of the accused, in cases of homicide. In crimes less than homicides, and especially where the intent is not a necessary element to constitute a degree or phase of the crime, this rule does not apply.

A Study of the Hymen as it appears in Mexican Women.—Prof. Francesco A. Flores has made a very full and exhaustive series of observations upon the forms and medico-legal value of the hymen as it is found in native Mexican girls and women.[42] These observations have been published in a pamphlet, kindly forwarded us by Dr. Soriano, one of our corresponding editors in Mexico,

admirably embellished with lithographic plates showing the typical, as well as the unusual, forms which the hymen presents. Prof. Flores gives the following as his conclusions:—

1. The complete absence of the hymen is rare in Mexico.

2. The regular forms observed are:—the annular (symmetrical and asymmetrical), the labial, the semilunar and the horse-shoe shaped.

3. The fringed hymen is not an autonomous form, but a variety of all the others.

4. Anomalies are not rare (8 per cent.), and some of them (as the biperforate hymen), seem to be observed with more frequency than that ascribed to them by European authors.

5. The study of the form of the aperture is of importance in legal medicine; it varies according to its amplitude and the greater or less obstacle which the hymen opposes to the introduction of foreign bodies.

6. The hymen, as the natural operculum of the vagina, presents a resistance which, measured by the mechanical force spent in overcoming it, can be expressed for the labial, annular, horse-shoe and semi-lunar hymen as follows:—6 : 4 : 3 : 2.

7. The resistance of each one of these forms is an important datum to aid in solving the questions that are put to the experts.

8. The relative frequency of the forms of the hymen varies at different ages, the labial predominating over the annular in girls, until the tenth year; the annular being more common from that age upwards.

9. The study of the forms of the hymen with reference to rape and to the violation of maidens, must be made on girls over ten years, for it is at that age, very nearly, that the hymen takes its definite form, and also because, at that age, these crimes are most numerous.

10. The hymen changes its form with age;—being labial in the majority of girls, it is converted into annular, semilunar, etc., in young women.

11. The hymen comes from the fusion of the lower portion of the sac of the oviducts; it is, then, a part of the vagina and of the internal genital organs, and therefore of the inner layer of the blastoderm.

12. The primitive hymen is the imperforate. Later, reabsorp-

tion taking place, there appear with it the different forms already studied.

13. Anomalies result either by the torsion of the oviducts, or by the late and asymmetrical reabsorption of the membrane.

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MEDICAL DEMOGRAPHY.

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THE designation here applied to a department of medicine, while not unusual on the continent of Europe, is unfamiliar to English speaking people, and when, at my instance, it was made with Climatology, the title of Section XVI. of the Ninth International Medical Congress,[1] I found myself called upon to explain its relations to our science. When I was appointed to the presidency of that section, it was entitled "Climatology, Vital Statistics, Collective Investigation and Medical Nomenclature," the awkward length of which suggested to me the necessity of determining upon some common term, under which the final three subjects might be included, and it occurred to me that Demography appropriately served this purpose. I have, accordingly, ventured to define *Medical Demography*, (δῆμος, γράφειν,) as that branch of medicine which is concerned with the study of vital phenomena, as manifested among human beings collectively, treating of the fecundity, natality, viability, morbidity and mortality of a people, and of the influences of climate and other external agencies, local conditions and customs, in accomplishing ethnic modifications and changes, tending to density or sparseness of populations and showing their rates of increase, retardation or loss. It is thus associated with Climatology, and embraces *Collective Investigation*, which gathers the material for its study, and *Vital Statistics*, which is the numerical statement in a classified arrangement of this material, to which *Medical Nomenclature* is instrumental. Its intimate relations with Climatology and Hygiene appropriately give it place beside them in medical literature.

A department of so recent institution can not present, in an annual summary of medical progress, such a coherent exhibit as if long established and its province generally recognized. It finds its material inchoate or in possession of other departments, and

consequently can not look for zealous investigators and contributors; or if there be the latter, they are apt, in the beginning, as I have experienced, to consider whatever is of foreign origin legitimate, and to collect data about strange drugs, clinical histories of individual cases, and peculiar methods of treatment and operative procedure, which properly belong to Materia Medica, Therapeutics and the practical branches of our art.

The study of human races, in a pathological point of view, which is the office of Collective Investigation, has only lately attracted attention in our profession, but it ought not to be indifferent to the physician, since the knowledge of the ethnic elements concerned in forming a population, enlightens him as to their physiological aptitudes and their pathological tendencies. The volumes of periodical medical literature are inordinately swollen with useless repetitions of reports of single cases and of matter to be found in students' text-books, to the exclusion, complains one medical editor, Dr. Waugh,[2] of Philadelphia, of comprehensive statements of diseases prevailing in communities, regions or countries. A spontaneous movement toward the collective investigation of facts relating to the most common diseases is, however, taking place, especially in England, France and America, but it is to a large extent the work of individuals, and the volunteer efforts in this direction by private practitioners have not accomplished what their enthusiastic projectors have sought. Indeed, the multiplicity of ventures of this sort has grown to such objectionable proportions as to elicit the sharp criticism of another medical editor, Dr. Foster,[3] of New York. With better prospect of success, a conjoint committee of the American and British Medical Associations have instituted inquiries as to the prevalence of certain widely spread diseases, a preliminary report of which by Dr. Isambard Owen,[4] of London, as to the distribution of cancer, rickets, etc., in Great Britain was presented to the section on Medical Climatology and Demography at the Ninth International Medical Congress. Dr. D. H. Cullimore,[5] of the Indian Army, has prepared an elaborate demographic review of the distribution of hepatic abscess, to which fuller reference will be made among the Indian reports. Dr. C. F. Larsen[6] has done similarly effective work of collective investigation in regard to the prevalence of pulmonary consumption in Norway, having prepared the following tabular exhibit of twenty-

two years' carefully collated experience, showing a slow and continuous increase of this disease in that country:—

Years.	Percentage of entire death-rate.	No. per 1000 of living population.	Years.	Percentage of entire death-rate.	No. per 1000 of living population.
1863	12.7	2.34	1874	14.5	2.62
1864	14.0	2.43	1875	14.4	2.69
1865	14.3	2.35	1876	14.2	2.68
1866	14.3	2.40	1877	16.1	2.86
1867	13.5	2.46	1878	15.9	2.51
1868	14.0	2.57	1879	17.0	2.56
1869	15.8	2.68	1880	16.9	2.70
1870	14.3	2.30	1881	15.8	2.67
1871	14.4	2.43	1882	14.7	2.71
1872	14.9	2.48	1883	16.2	2.77
1873	15.2	2.55	1884	15.8	2.60

These results are interesting in comparison with the declaration of the President of the South Australian Branch of the Adelaide Society[7] that the mortality from phthisis in South Australia is only 1.008 per thousand inhabitants, as against 2.065 per thousand in England and 3 per thousand as the general average of all other countries. As in the case of the English statistics, the mortality from this disease among men was greater than among women.

Effective collective investigation must, however, be the systematic work of a national department, bureau or commission, established by the several governments, under the direction and control of a central authority, and conducted so as to avoid annoyance to individuals or the appearance of personal interest in results. In the United States, some of the State Boards of Health have instituted limited investigations; but very few of these bodies are provided with *personnel* or means sufficient for more than the sanitary supervision for which they were created, while uniformity and completeness can only be secured by an organization extending over the whole territory of each country. Until late years compilers of vital statistics have not essayed the tabulation of anything beyond births, deaths and marriages; but the recent recognition of the importance of preventive medicine has made manifest that the mere enumeration of deaths is insufficient evidence of the influences operating to impair the physical condition of a people. Consequently, the need is felt of an accurate exhibit of the nature and extent of prevailing diseases—the precise kinds and number of cases of each—showing the absolute daily number of men, women and children sick in a community, as well as those born into it and those leaving it by death. Nowhere yet, however, have

complete morbidity returns been accomplished, so that one only source of information, especially as to distant places, is that derived from the consensus of writers and students of ethnography, who gather a popular rather than a scientific understanding of existing disease. The Italian Government has taken a preliminary step in this direction, the Minister of the Interior, in a circular dated January 9, 1885, having addressed the Italian communes a series of questions drawn up by the Superior Council of Health, in concert with the Superior Council of Statistics, the replies to which have been summarized and published under the supervision of the Director General of Statistics, Signor L. Bodio,[8] comprising information as to the topography, climatology and hydrography of each commune, the hygienic condition of dwellings, lavatories and cemeteries, the food supply and consumption of fresh meat and vegetable produce, movements of population, morbidity, mortality, etc. The Section on Climatology and Demography at the meeting of the Ninth International Medical Congress at Washington, September 5–10, 1887, adopted a resolution,[3] which I presented and which the Congress in general session endorsed, to the effect that it is important that there should be established in every country, a national department, bureau or commission for the record of Vital Statistics upon a uniform basis, to include not only accurate records of births and deaths, but the results of collective investigation by governmental officials of facts bearing upon the natural history of disease, as manifested among men, women and children, especially with regard to the climatic and other discoverable causes of disease—age, residence and occupation being also made matters of record—that necessary preventive measures may be determined and enforced for the preservation of the public health. Later, the Sixth International Congress of Hygiene and Demography, at Vienna, September 26–October 2, 1887, gave expression to the growing sentiment in favor of systematic collective investigation by adopting resolutions offered by M. Schiavuzzi[10] of Pola, Austria, setting forth the necessity for a general inquiry by every country into the medical history of malaria, with a view to establishing definite statistics of this disease. It is a matter of history that Pola, which, under the Romans, was a city of thirty-five thousand inhabitants, had become at the beginning of this century, a village of only six hundred, a fate which has befallen other towns in

Istria, the decadence having been shown by M. Schiavuzzi's own investigations to be due to miasmatic influences developed in that region; and it is known that the inundation of Sybaris, the renowned seat of luxury and pleasure, by the divergence of the course of the river Crathis, during the Crohnian War, 510 B.C., converted its site into a desolate, pestilential swamp, the home to-day of a sparse and sickly population whose ills are laid to the account of their insalubrious climate.

Experience has proved that the compilation of statistics must be the work of men especially qualified, and while the sanitary organizations are gradually preparing such a class, some of the returns of these bodies exhibit manifest short-comings, as in the instance quoted by Dr. Barker[11] of New York, when for a certain time, no epidemic or unusual sickness prevailing, the deaths in the city of Liverpool, exceeded the reported births. Inaccurate or incomplete returns are worse than useless, since they vitiate everything into which they enter, and consequently, it is only possible, at this time, to refer generally and cursorily to the customs, conditions and morbid tendencies of such people concerning whom reports have been received, as the first step toward the proper future systematic study of Medical Demography. This much we know definitely now, that the general death-rate is diminishing and the average length of human life and the duration of a generation on the earth, proportionately increasing. Inferentially, there are, in all probability, fewer days of sickness *per capita* than when observers began to keep record of such matters, but precisely what diseases prevail, their local or other causes, the definite geographical limits of each, the effects of climate and custom in modifying them, the susceptibility or immunity due to ethnic peculiarities,—these we only know in a general way. To gather precise information on all these points will be the province of Medical Demography; and this involves inquiries into the ethnography of a people, its social and domestic customs, marriage, occupation and education, and all the circumstances of its physical environment. M. Körösi,[12] the statistician of Buda-Pesth, has come to the conclusion as a result of his computations of the life-time of the various classes of humanity, that the wealthy class to-day averages fifty-two years of life, the middle class something less than forty-seven and the poor rather more than forty-one and a half, the possession of riches and

the exemption from privation thus adding over ten years to human existence. Considering the diseases fatal to mankind, he finds that cholera, small-pox, measles, typhus, consumption and pneumonia are eminently enemies of the poor, while diphtheria, croup, whooping-cough, scarlet-fever and cerebral affections especially assail the rich.

It is probable that all diseases of which we have any knowledge are common to the human species, and that while none have an absolute immunity against any one form, manifest unequal morbid proclivities are recognizable among the several races. It has been claimed that the black race is unaffected by paludal fevers, by dysentery and especially yellow-fever, diseases ordinarly fatal to whites in hot countries, but this is now known not to be absolutely true. The statistics of Bondin concerning the diseases of the French colonies, demonstrate that the mortality among whites and blacks rises and falls alike, but always greatest among Europeans, which agrees with the experience of Americans in the Southern States that the negro offers a greater resistance than the whites to yellow-fever, paludal fever and legative affections without being absolutely exempt. Clément[13] says the observations of French colonial physicians show that all races are subject to cholera, but that they are not equally susceptible, instancing the mortality of Guadaloupe in 1865–6, when the fatal cases among the Chinese amounted to 2.7 per centum, Hindoos 3.86, Whites 4.31, and Negroes 9.44. Social condition and the *modus vivendi* have, however, so much to do with liability to this disease, that instances of apparent immunity are not always real. Dr. Ad. Nicholas[14] having questioned the existence of typical typhoid fever of Europe in tropical countries, Dr. Carreau[15] of Pointe-à-Pître, Guadeloupe, declares that while his own experience confirms the opinion of Dutroulau that this disease is more rare in the Antilles than in the other colonies, recent clinical and autopsic evidence has established the existence of veritable dothienenteritic fever; and consequently the local physicians were wrong in declaring that typhoid fever, rare n that climate, could attack the newly-arrived European, but never any of the Creole population. It is perhaps true that in Algeria typhoid fever scarcely affects the Arab inhabitants, while it fatally attacks Europeans. Dr. Cullimore[16] insists that there is some greater and more expansive agent than individual habits control-

ling the diseases of climates so different as those of Northern Europe and the torrid zone. As the varied regions of the habitable globe have their natural fauna and flora, in like manner is it with the black and white races of man; neither can overstep its limits without danger, deterioration and ultimate extinction. Sanitary and hygienic precaution and individual care may lessen the danger and delay the deterioration, but the inevitable doom, however long deferred, we can not avoid. This is but an adjustment of the law of nature without which all the weaker races of tropical regions would in time become as extinct as the aborigines of the more temperate countries of North and South America, Australia and South Africa.

Imported diseases vary in their endurance on soil in which implanted. The European contracts cholera, but the disease will not live in Europe, while pulmonary phthisis, until then unknown among Polynesian negroes, after contact with the whites became a fatal scourge of the blacks, as it is of those in the United States. Variola brought to America by Europeans still thrives virulently and is only repressed by unremitting sanitary vigilance. Syphilis, notwithstanding its antiquity and universal distribution, according to Diday shows a marked preference for the Latin races. Leprosy flourishes to-day in Russia and Turkey as in its earlier sites in Denmark and Lombardy, and brought from China to Hawaii has found the latter so congenial a habitat that it has become one of the active agents in the destruction of the Hawaiian race. Pellagra once believed to be circumscribed within geographical bounds is now known to spread wherever the greed of commerce carries the wretched provender which develops it. The medical demographer has, therefore, in his study of the problem of human development, to consider besides moribific climatic influences, racial peculiarities and how these are modified or antagonized by diet, occupation, residence and social condition. Buckle long ago demonstrated how the spirit and character of a people are dependent upon material circumstances, notably diet. Indeed, a great demographic experiment has been in operation in Ireland for years, where an effort has been made by a nation to subsist on a food of low histogenetic value—the potato—with disastrous effects upon health and character.[17] The Chinese of the northern provinces live on millet, wheat and vegetables, because

these thrive best in the dry and dusty soil and severe winter, while the moist hot climate of Southern China produces rice, which with fish is the staple aliment of many millions of human beings. The lack of variety harmonizes with, if it does not induce, the changeless conservative characteristics of the people. The European wearies of it, becomes dyspeptic, anæmic and dies. The influence of habitation has been pointed out by Professor Geikie,[18] of Toronto, in the case of pneumonia, which is not extremely prevalent in the high latitudes of North America, where cold and dampness prevail, nor among the wretched homes of the poorer classes, but among the comfortably housed and well to do inhabitants of the large cities of Canada. The effects of city residence, especially in manufacturing centers, in influencing physical development is so great that the urban dweller is recognizable by his shorter stature, darker complexion and peculiar traits, as by his marked liability to reveal affections. The effect of town-life, according to Fothergill,[19] is to produce a distinct retrogression to a smaller, darker precocious race of less potentiality than the rustic population. Lacassagne[20] proposes to demonstrate, by an extended series of cephalic measurements, the influence of intellectual work upon the shape and development of the skull. Dr. George Harley,[21] in a paper read before the Anthropological Institute of London, says that in spite of civilizing influences being potent agents in improving man's physical as well as mental condition, increasing alike his stature and his strength, as well as extending his length of days, they materially diminish instead of augmenting his bodily recuperative powers. Among other illustrations of this differential power of recuperation, Dr. Harley refers to the facility with which childbirth is accomplished among savage and uneducated women as compared with women of culture and refinement, to whom it is always an incident more or less tedious, involving four to fourteen days prostration and anticipated with apprehension and dread of a fatal result which is not uncommon. Among Fijian women,[22] as will be referred to farther on, parturition is ordinarily speedy, easy and unattended with the concomitants usual with European women, the diseases incident to the puerperal state being wholly unknown; among the Zulus[23] labors are simple, miscarriages rare and abortion never practiced; with the Pitcairn Islanders[24] the parturient act rarely lasts more than five hours and

has never proved fatal; and Dr. Krusenstein[25] of the Tiflis Lying-in Institution reports pelvic contractions and difficult labors very rare among women born in the Caucasus. The effect of high-breeding on animals shows a similar deterioration in recuperative power, parturition being accomplished by dogs, sheep and horses of a fine pedigree with difficulty and pain. Hence, it appears that the recuperative bodily power of the animal diminishes as we ascend the scale of organism and in man, the highest animal, deteriorates still further under the influence of civilization and mental culture, although mere strength and development of the body may at the same time increase. The red races of America are perishing in their own climatic home by reason of the vices of civilization. Dr. Matthews,[26] of the United States Army, declares that consumption increases among the American Indians under the influence of civilization, climatic conditions being, of course, unchanged and these being normal to them as aborigines. It is the compulsory endeavor to accommodate them to the food and habits of an alien and more advanced race, and climate is no calculable factor in this increase. The physical decline of the natives of Rapa-nui (Easter Island) began when French missionaries evolved out of nude savages a race of clothed and pampered pseudo-Christians. The population of New Caledonia[27] was reduced sixty-seven per centum in only fifty years after European intervention. At the period of the discovery of the Sandwich Islands, in 1778, the Hawaiians, according to Surgeon George W. Woods,[28] United States Navy, were physically and mentally superior to all the other Malayo-Polynesian races. Climate, soil and general environment having remained the same, we must look to the altered conditions of the new mode of life effected by civilization in their laws, religion, government, language, manners and customs, and to the implanted germs of disease attendant upon it, for an explanation of the astonishing demographic changes which a century has wrought in the Hawaiian race. The first effect of the contact of civilization was inoculation with syphilis; later came epidemics of scarlet-fever, measles and small-pox; and finally, Chinese immigration introduced leprosy. Numbering over four hundred thousand at the time of Cook's first visit, the population had been reduced to one-fourth that number in 1836, to one-fifth in 1850, and at the present day to less than one-tenth, as

the result of a century of civilization in a pure-blooded race. The following table exhibits the rate of decrease since 1850:—

YEAR.	HAWAIIAN POPULATION.	DECREASE.	ANNUAL PERCENTAGE OF DECREASE	YEAR.	HAWAIIAN POPULATION.	DECREASE.	ANNUAL PERCENTAGE OF DECREASE
1850	82,203		1.85	1872	49,044	9,721	1.68
1860	66,984	15,219	2.04	1878	44,088	4,966	1.58
1866	58,765	8,219	2.75	1884	40,014	4,066	

While the native race is still diminishing with such rapidity, there has been a marked abatement in the rate of decrease, due to sanitary legislation and the segregation of the lepers. At the same time, immigration is rapidly supplanting the Hawaiian loss, and amalgamation with foreign races is taking place, the half-castes having increased from 3420 in 1878 to 4218 in 1884. The aggregate population of the eight islands of the little kingdom, which, in 1873, was 56,897 and in 1878, 57,985, had risen to 80,578 in 1884, the foreigners already constituting more than half.

Increase of Population in Europe during the past thousand years.—M. Inawa Sternegg, of Vienna, at the Sixth International Congress of Hygiene and Demography, considered the development of the population of Europe during the last thousand years, with which began its political reconstruction out of the heap of ruins, which was all the downfall of Rome left of the ancient world. Notwithstanding the foreign emigrations which had been going on for two hundred years, the first centuries of the new era had not contributed greatly to the augmentation of population, life and property having been constantly menaced by war, pillage and disease, especially the great plague of the sixth century. From this down to the fourteenth century, the extension of population was remarkable, and led to the desire to found new communities, which became so powerful a motive that the great wars and the two millions of European lives sacrificed during the Crusades were not able to arrest it, and added scarcely one per thousand to the adult mortality.

The distribution of the population of Europe at the middle of the fourteenth century was quite different from that of the preceding eight hundred years. The greatest density, at this period, was in Italy, France and Spain. The German race had participated largely in the extension of European population, but the German

countries did not at the same time attain so great a density of population. The increase was abruptly checked, in the middle of the fourteenth century, by the plague, which during the thirty-five years of its prevalence, carried off twenty-five millions of victims, one-fourth of the entire population. Scarcely had the new generation, reared under such unfortunate conditions, began to progress, when the religious wars of the sixteenth and seventeenth centuries, the Turkish domination during the same period, the expulsion of Moors and Jews from Spain, the civil wars of England and Scotland, the German peasant wars, the Spanish interference in Italy and other causes, conspired to again retard the growth of population. The end of the seventeenth and the eighteenth centuries saw the cities gain in number of inhabitants, while the country at large remained stationary.

Only at the commencement of the nineteenth century did the number of births very largely exceed that of deaths. In the last eighty-seven years, the population of Europe has doubled. From one hundred and seventy-five millions in 1800, it has now risen to three hundred and fifty millions, and this in spite of wars, emigration to America and grave epidemics, and this increase is the more notable when each country is separately considered. German Europe has doubled its population in sixty years, while in France this only took place at the end of two hundred and in Italy, one hundred and seventeen. The Oriental nations are also increasing. To attribute this great economic movement to the multiplicity of modern means of communication and to increase of marriages and consequently of births, is only the lesser side of the question. Saxony and Servia have doubled their population in fifty years; England and Norway, Greece and Roumania, Prussia and Scotland, Denmark, Sweden and Finland in seventy, the principal cause of which has been the progress of hygiene and public morality, inducing efforts of modern society to improve the material and social position of the working classes and great masses of the people.

Longevity in England and America.—An English editorial writer[30] regrets that the imperfect system of registration of vital statistics in America prevents the possibility of a useful comparison as to the relative longevity in England and America. The rapid growth of life assurance in the United States has, however, accu-

mulated a valuable mass of statistics of mortality among the middle and upper classes, who constitute the insured. Among the more interesting results shown by the tables representing the experience of thirty American life assurance offices, may be noted that the expectation of life of insured males in America at twenty years of age is 42.1 years, exceeding by one year the similar expectation of English males; and of American females 40.8 years, which is precisely the same as that of English women. After the age of twenty, the expectation of life among American women exceeds that of English women up to forty-seven. One other feature discovered by the tables is that in America women have a lower expectation of life than men after the age of thirty-five, while in England it is better with women than men.

Depopulation of Parts of France.—M. Guirard,[31] of the French Society for the Advancement of Science calls attention to the serious depopulation of the Southwest of France, which he attributes (1) to the increase of urban accumulations with their greater death-rate, at the expense of the rural districts, and (2) to insufficient natality,—this not keeping pace with the growth of commerce, fertility of soil, and wider distribution of property, and due to economic and voluntary social causes, inducing infecundity of marriages. A demand is made for governmental investigation, and, if possible, the diminution of the great mortality of young children by protecting them against parental prejudice, ignorance and neglect.

The rapidity of depopulation is manifest on contrasting the population of ten contiguous departments of the Southwest with that of fifteen years before:—

DEPARTMENTS.	POPULATION. 1861.	POPULATION. 1875.	DECREASE.	LOSS PER 1,000.
Ariège,	251,850	244,795	7,055	28.
Charente,	379,081	373,950	5,131	13.6
Charente Inférieure,	481,060	465,628	15,432	32.
Dordogne,	501,687	489,848	11,839	23.5
Haute-Garonne,	484,081	477,730	6,351	13.1
Gers,	298,931	283,546	15,385	51.4
Lot et Garonne,	332,065	316,920	15,145	45.6
Basses-Pyrénées,	436,628	431,525	5,103	11.6
Hautes-Pyrénées,	240,179	238,037	2,142	8.9
Tarn et Garonne,	232,551	221,364	11,187	48.1
Aggregate,	3,638,113	3,543,343	94,770	26.

These departments comprise all Southwestern France, except the Gironde and Landes, the former of which has gained in population through the increase of that of its chief city, Bordeaux, which rose from 123,935 in 1851 to 212,111 in 1876.

An even greater decrease in population has been going on in the Northwest of France, though over a more limited territory, as here indicated:—

DEPARTMENTS.	POPULATION.		DECREASE.	LOSS PER 1000.
	1861.	1876.		
Calvados,	480,992	450,229	30,763	63.9
Eure,	398,661	373,629	25,032	62.7
Manche,	591,421	539,910	51,511	87.0
Somme,	572,646	556,641	16,005	27.7
Aggregate,	2,043,720	1,920,409	123,311	60.

The department of Seine Inférieure, which has increased from 789,988 to 798,414 is an apparent exception, but the growth of the city of Rouen from 91,512 to 104,893 explains the increase as that of Bordeaux in the case of the Gironde. That the loss still continues is evident from the most recent statistical returns[32] from twelve of the chief places of the department of Seine Inférieure (Rouen, Le Havre, Dieppe), Calvados (Caen) and Manche (Cherbourg) representing the excess of deaths over births, as follows:

	BIRTHS.	DEATHS.	STILL-BORN.
July, 1887,	935	1,009	63
August, 1887,	903	1,328	52

The increase in population in the whole of France, during the seventy-five years from 1801 to 1876, allowing for the alterations of territory, which took place in 1860 and 1871, amounted only to forty-three per thousand, so that it would require one hundred and sixty-one years to bring about the same doubling of the population as is taking place in England in fifty-three.

The defective birth-rate of France, or its *natality*, a term used by Achille Guillard to designate the reproductive energy resulting in new births, or the frequency with which births happen with regard to the number of living beings who produce them, is attracting serious attention in that country. Dr. Lacassagne[33] calls atten-

tion to the value of the statistics being accumulated by the municipality of Lyons, as a basis of an accurate local demography. He states that the annual mean of births in France has been from 940,000 to 970,000, and that while in the decade 1770–80 there were 380 births in ten thousand, in the period 1861–68 there were only 264, and from 1869 to 1880 the number had fallen to 245, an average very far below that of other countries. In France, there are scarcely three births to a family, and of three hundred born only one hundred and ninety-two reach twenty years of age. As to sex, among country people there will be one hundred and seven males to one hundred females, in cities one hundred and five girls to one hundred boys. Illegitimate children exceed one-third the legitimate, reducing the excess of males. There were more births, both legitimate and illegitimate in February, and next in March, April, June and January successively, showing that the maximum number of conceptions took place in May, June, July and April, this influence of the seasons being more marked in the country than in the cities.

With respect to Lyons alone, notwithstanding the increase in the population of the city, the proportionate number of new-born children diminishes, the births among ten thousand inhabitants having steadily fallen from 283 in 1861–'65, to 255 from 1865 to 1871, 273 from 1872 to 1876, 254 from 1877 to 1881, 248 from 1882 to 1886, and later still to 220—that is to say ten thousand Lyonnese to-day produce sixty-three children less than the same number of inhabitants twenty-five years ago; and while there are fewer natural births, this is not due to a higher morality, but it seems as if the race were really losing the faculty of reproduction. Fluctuations in number during this period have followed economic crises as markedly as war-times.

Ethnography of Lyons.—The French are, at this time, the most zealous inquirers into every thing relating to the origin and perpetuity of their race, both at home and among their colonial possessions. Clément[34] has entered upon an exhaustive study of the ethnography and demography of Lyons and its entours in the department of the Rhone, and commences by tracing the various components of the Lyonnese population to their historical beginning. The earliest inhabitants of this region, he identifies with the race of Cro-Magnon, whom Dr. Bertillon, from a study of

skulls of the Algerian tribe of Kroumys, finds reason to believe were forced by the invasion of the Celts out of France into Spain and across the sea into Algeria, where the primitive type remains. Bands of Phenician navigators settled among the Celtic intruders and later colonizing Greeks, who were in turn followed by the conquering Romans. Notwithstanding its part in the history of Lyons, Rome seems to have left only the legacy of her language and civilization, without contributing to the formation of the race. Before the end of the Roman occupation, the soil had been restored to its ancient possessors and no Latin blood courses through the veins of the people. Consequently, when the population of Italy, which was already a heterogeneous mixture when Lugdunum (Lyons) was founded, 59 B.C., by Greek refugees from the banks of the Hérault, came to colonize, they mingled readily among the indigenes. Three principal elements have combined to form the modern Lyonnese people, Celts, Ligurians and Burgundian Germans, all others having played a secondary rôle and failed to impress their characters on the population. The Burgundian influence is manifested in the somewhat greater stature than the French of other provinces and in the modified coloration of the skin, hair and eyes; for though the Celtic and Ligurian blood is in predominant excess, the Burgundian admixture has been sufficient to cause numerous intermediary tints, while the extreme black of the Ligurian and the pronounced white and red of the German are seldom seen. The disappearance of pure blondes is noticeable in other countries. Dr. Clément found his most important evidence of ethnic characteristics in the shape of the head (indice céphalique). Using the ordinary hatter's conformator, he discovered, as the result of a number of measurements of the various classes of the inhabitants of Lyons, that the brachycephalic skull (Ligurian) is the characteristic form, being four or five times more common than the sub-brachycephalic (Celtic), no dolichocephalic (Burgundian) forms at all being encountered. It is not strange that the latter should disappear since it belonged to the least numerous race, and in the crossing of races, a lower degree of the brachycephalic type has taken its place. Historically, the Celts constituted the dominant class, but according to cephalic indications they are now outnumbered nearly five times by Ligurians. This has not been due altogether to excess of immigration of Provençal population over

that of neighboring departments, as local conditions, especially urban habitation, have tended to modify the shape of the head by augmenting the cephalic index.

Relative to the ethnic indications of color of hair and eyes, Dr. Paul Topinard,[35] General Secretary of the Anthropological Society of Paris, is framing a chart of the color distribution of eyes and hair in France, on the model of the charts published by Broca, 1860–66, giving the heights of the various races forming the French populations; and the French military and naval surgeons have entered upon the inquiry with the same interest they have evinced in other statistical investigations. The information sought respecting color, with that already possessed concerning stature, and that being also gathered relative to cephalic and nasal indices, will contribute greatly to the knowledge of the distribution and degree of admixture of the constituent national races.

Algeria.—French ethnographers are studying with satisfaction the increase of European population in Algeria, in which, according to Le Roy Beaulieu,[36] the French element is markedly in excess, at a rate which promises to double in about fifty-six years, being more than twice that of France itself. At the close of the century, it is estimated that the European population, representing a fusion of French, Spanish, Italian, German, Swiss and Maltese immigrants, will number seven hundred thousand, keeping pace with the foreign growth in the Australasian colonies of Great Britain, which sixty-three years after the frigate Sirius landed eight hundred convicts at Botany Bay, numbered, including New Zealand and Tasmania, only four hundred and thirty-five thousand.

The French element in the Algerian population is, however, far from pure, and the proportion of foreign admixture goes on increasing. According to the census of 1886, the French and Algerian French, excluding native Jews and the French military establishment, numbered 225,660; other natives excluding the foreign legion, 210,203; the other Europeans appearing as, 144,-530 Spaniards, 44,315 Italians, 15,533 Maltese English, 4,863 Germans, chiefly Alsatians, and 2404 Swiss.

Egypt.—Dr. H. R. Greene,[37] of Cairo, declares that the population of Egypt is likewise increasing in a remarkable manner, notwithstanding the excessive infant mortality, and quotes from Dr. Engel's published demographic reports, as follows:—

YEAR.	EXCESS OF BIRTHS OVER DEATHS.	EXCESS OF DEATHS OVER BIRTHS.
1880	50,858	
1881	73,935	
1882	60,444	
1883	. . . .	15,017
1884	67,775	
Aggregate (5 years)	237,990	

In 1883 there was a severe epidemic of cholera, but notwithstanding, the population of Egypt increased during these five years nearly a quarter of a million. The results of 1885 and 1886 are equally favorable.

Dr. Grant (Bey)[38] calls attention to the destruction of life and consequent influence on the number of births in Egypt from craniotomies performed by ignorant midwives; and the thousands of criminal abortions practiced by them are also a factor in reducing the normal birth-rate. Incidentally, he refers to the practice of circumcising both boys and girls at the age of four years, the operation in the case of the latter involving the labia majora along with the clitoris. Sixty per centum of the infant mortality of Brazil, which is as alarming as that of Egypt, was attributed by Dr. Moncorvo[39] to hereditary syphilis, rickets coexisting in five per centum of these.

The extensive possessions of the French in Asia have made that region an attractive field for investigators of that nationality, whose reports are accumulating a mass of information, which will be of value to the future demographer. Until other regions are similarly investigated and upon definite parallel lines of inquiry and exact statistics obtained, which can be stated in numbers or tables of numbers, or in a tabular or classified arrangement, no comparisons are possible nor basis for generalizations or deductions afforded.

Cochin China.—The population of Anam, which, with Tong-King and the French colonies, constitutes the eastern part of the Indo-Chinese peninsula, is clustered, according to Dr. H. Rey,[40] around the delta of the Tong-King, which resembles an immense ant-hill, where for years almost all the population of the vast neighboring regions has been congregating, less than three-tenths of the whole living in the interior and mountainous regions, and

this by reason of the native preference for the rice-swamps and the insecurity and relative unhealthfulness of other regions. According to Mondière, the males predominate in the same proportion as in Europe, there being among a thousand births,

	OF THE MALE SEX.	OF THE FEMALE SEX.
In Tong-King, . . .	519	481
In Europe, ...	514	486

Moreover, the monthly mean of births being one thousand, the maximum, 1133, is reached in January, after conception in April, the season of greatest activity, this also corresponding with France, in which, as has before been stated on the authority of Lacassagne, the greatest number of births, both legitimate and illegitimate, occurs in February, the maximum of conceptions having taken place in May. The month of minimum births in Anam is June, 867, after conceptions in September, following the season of greatest heat. The annual excess of births over deaths is 151 per thousand, the annual natality gain being consequently double that of France, which is only 75. The following table represents the distribution by age among a thousand decedents, Anamite and French:—

AGES.	ANAMITES (MONDIERE).	FRENCH (BERTILLON).
Under 1 year,	93.7	203.7
From 1 to 5 years,	119.0	119.6
" 5 to 10 "	116.5	33.8
" 10 to 20 "	135.6	47.1
" 20 to 30 "	130.3	65.8
" 30 to 40 "	121.3	58.0
" 40 to 50 "	119.5	64.9
" 50 to 60 "	79.2	84.6
" 60 to 70 "	51.4	127.2
" 70 to 80 "	20.5	130.6
" 80 to 90 "	9.3	59.8
" 90 to Ω "	3.7	5.4
	1000.	1000.

There are consequently few old persons in Tong-King, the characteristic of the Anamite mortuary being the great loss of life during the ages of greatest energy and greatest productiveness, thirty-seven per centum dying between twenty and fifty years of age, as contrasted with nineteen per centum during the same period in France. The mean length of the Anamite's life according to Dr. Collomb is 29 years. Mondière places it at only 26.5 years for men and 27 for women, the average in France now being 35.

The population of Tong-King comprises Anamites, Muongs

and Chinese. According to Maurel[41] all Indo-China was primitively occupied by a black population of graceful form, straight eyes and more or less prominent nose, probably a Malay race, displaced by invaders from the confines of Thibet, having a common origin with the Siamese and Burmese. The Muongs, or savages as they are called by the Anamites, inhabit the mountains, but physically do not essentially differ from the latter, though not intermingling with them and rigidly maintaining their own customs. The physical influence of Chinese settlers on the race has been slight from the fact, that these have been chiefly males. The traces of Chinese blood quickly disappear, while their civilization is imparted as was that of the Romans upon the Gauls. The name *Giao-chi* (orteils écartés) given to the ancestors of the modern Anamites, indicates a physical peculiarity which still survives in the separation of the great toe from its fellows, and its remarkable motility, making it a veritable organ of prehension. The Anamite race of Tong-King is higher in the ethnic scale than that of the rest of Cochin China. Few individuals are met who are deformed, lame, hunchback or deaf and dumb, but the blind are numerous from small-pox.

Sexual precocity is characteristic of the race, the sexual appetite being developed at fourteen or fifteen and so freely satisfied that no girls pass that age without loss of virginity, (Mondière)[42] and incestuous intercourse of brothers and sisters is so common that a missionary declares that "for a girl to be still a virgin at twelve, she must have no brother." The first menstruation does not appear until after sixteen, and though marriage takes place at eighteen, the first parturition does not occur until twenty or later, the retardation being due to premature and unlimited gratification. Four to five children during twenty-eight years represent the average fecundity. Parturition is easy, the only pain suffered being that caused by the passage of the child through the vulvar opening. Spontaneous abortion is rare, but is often induced by drinks and blows, and is commonly attended without other accident than hemorrhage and slight metritis. The newborn child does not feed for two days, or if given milk, it is not the mother's but that expressed from neighbors' breasts; for the Anamite woman, while willing to give suck to a strange child, will not do so until after it has already taken its mother's breast, lest maladies without

number befall her. Among the lower classes, infants nurse for two years, a second pregnancy rarely occurring before the second year. In the mandarin class, children nurse to the age of six or seven, and hence it is not rare to see young girls and women past the menopause with milk in their breasts.

In a paper summarizing the prevailing diseases of the *Yellow Races*, Dr. Verrier[43] states that scrofula is a very frequent and grave constitutional malady among them, contributing to render the ophthalmias to which they are subject so intractable, and occasioning the ganglionic enlargements, especially of the mesenteric glandulæ so often observed among the Chinese. This strumous disposition accounts for the phagedenic tendency of sores, notably of what is known as "la plaie Annamite," although wounds from firearms or cutting and penetrating instruments quickly cicatrize. The "ulcère de Brassac" has the pemphigoid form described by Mondière and was mistaken by Cazenave for a variety of leprosy, but it is due to scrofula rather than to the former or to syphilis.

Neither phthisis nor cancer appear to cause much ravage among the yellow races. The former is even unknown in Thibet, as well as among the Kirghis, but is met with among the Chinese coolies transported to Oceanica and America. While affections of the skin are frequent in China, they are those of a scrofulous nature, and epithelioma is not seen. Leprosy is very common and very serious.

The people of the yellow races are subject to cholera, intermittent fevers, dysentery and variola. Cholera is endemic in Cochin China, the Malay population of Anam succumbing to it more readily than the pure-blooded Mongol. According to Dr. Morice, the algid period is shorter and less grave than with Europeans, while the period of reaction is longer and more severe. Dengue, common in Senegal, Aden, Madagascar, India and Cochin China, seldom attacks Europeans and always mildly. The Chinese and even more the Anamites, notwithstanding their rice-fields and overflowing rivers, resist intermittents, natives enjoying a relative immunity while Europeans are attacked.

Small-pox has been known from the most ancient times in China and possibly originated there. Notwithstanding, inoculation and vaccination imported from Europe, it is so prevalent that a large portion of the race is badly pock-marked, and it is a daily

occurrence in crowded cities to be jostled by individuals in every stage of the eruption.

Vices of conformation, notably hare-lip, are common as are external parasitic diseases, tinea, itch and the like, due to uncleanly habits, and intestinal worms, derived from the uncooked and unwholesome food they eat from necessity, or from plants watered and manured with animal excrement. This probability is also advanced by Dr. Ira Harris,[44] of Syria, where one in every five of the population suffers from tape-worm, who attributes it to the practice of defecating in the open fields, whence the dejecta are scavengered by domestic animals and fowls, who in turn furnish food, which is eaten raw or scarcely cooked.

Notwithstanding their constitutional feebleness of reflex action, the yellow races, especially the Chinese of every station of life, are subject to mental aberration often inducing suicide. A common form of melancholic insanity is the "Scythian disease" of Hippocrates, due to the despair following loss of virility and often complicated among the people of the Caucasus, Thibet and Japan with zoanthropia. Tetanus is rare, as might be inferred from the feeble excitability of the great sympathetic system, and according to Dr. Bordier is never seen among the smokers of opium, the common use of which drug, he believes, also establishes a tolerance of alcohol and makes it efficacious in delirium tremens. The opium habit, doubtless, likewise explains in a degree the stoicism of the Chinese under surgical operations and their insensibility to the effects of chloroform.

Rabies has been epidemic in China, as in 1818, at Pecheli, when all the dogs spontaneously attacked each other and bit other animals and human beings. Similar epidemics have been known in Peru under the influence of prolonged high temperature. The mean duration of the disease in man is said to be six days and the mortality ninety-eight per centum. The Chinese claim to be in possession of a treatment, not like Pasteur's, which has reduced the mortality to one per centum.

China.—Dr. Henry T. Whitney,[45] of Foo-Chow, our corresponding editor, finds syphilis, after rheumatism, the most frequent disease among the people of that part of China, but his experience indicates that it is less virulent than among whites. Sodomy is common among youths, even beginning at seven years of age.

Tertiary ague, scrofula, anæmia, general debility and dyspepsia are frequent among the laboring classes, whose food consists chiefly of rice or dried potatoes, with turnip-tops fried in oil and a little dried fish or bean-curd, being bulky and deficient in nitrogenous elements, and hastily bolted. Suicide, as stated by Verrier, is exceedingly common, the means resorted to being the eating of opium or gold-foil, drowning, cutting the throat or cutting out the tongue.

The extreme frequency of dyspepsia in Shantung is referred to by Dr. Coltman, Corresponding Editor of the ANNUAL, in his report of diseases prevalent in that province. He says that it is described by such expressions as "the mouth of the heart pain," "inside of the breast pain," "belly-ache," "heart melancholy," "belly-stretched," etc.,—and is due to the large amount of millet-seed, broom-corn-seed, cabbage and onions, which, with poorer food, are made to supply deficiency of meat and bread, and in connection with the great quantity of hot water drank, induce gastric debility and ultimately anæmia.

Korea.—Dr. W. B. Scranton, of Seoul, Corresponding Editor of the ANNUAL, writes that diseases of filth, bad hygiene and vice prevail. Typhus and relapsing fever are endemic, the latter according to Dr. H. N. Allen,[46] known as *yem pyeng*, being the most dreaded disease of the country, because a person once affected is liable to repeated future seizures. Small-pox is seen everywhere and is as unnoticed as in China. Diphtheria and typhoid fever have not come to the knowledge of foreign physicians. Dysentery is common and cholera rages during hot weather. Syphilis is general and is treated by mercurial inhalations. The Korean is described by Dr. Scranton as shiftless and idle, very proud and dirty, a high-liver when he has the money, and a good rival of Tanner when he has none. Physically he is large and well-developed, mentally dull. He is not unacquainted with very poorly distilled alcoholic drinks and both sexes use tobacco largely. The women are sallow, anæmic, with flabby faces from the seclusion to which all but the lower classes are subjected, too much tobacco, bad air and probably syphilis. Their diet is chiefly rice and cabbage or turnips made into a kind of sauer-kraut with plenty of red pepper. Dog and horse-meat are both eaten freely. Nursing women tie a band tightly around the waist to cause food and liquids to take a more direct course to the breasts.

Japan.—The Japanese of to-day, according to Verrier[47] are for the greater part a mixture of Malays, Chinese, Koreans and blacks from Formosa and the Philippine Islands and in the northern islands a considerable proportion of the white-skinned, hairy autochthones, (Ainos), with almost dolicocephalic skulls, the pure yellow races forming only about one-third of the whole. The amalgamated population, therefore, participates in the physiological characters of the formative races and is subject to all the maladies of savage and civilized people with consequent precocious decrepitude. Syphilis, he finds as virulent as among the black races and phthisis is more common than in China, showing the influence of Polynesian blood. Cholera rages more among the Japanese than the Chinese. Malarial fevers have a typhoid character with tendency to collapse. The general anæmic condition of the race predisposes to *beri-beri*, which disease as well as *sen-ki* is regarded by the Chinese as of miasmatic origin. Strumous ophthalmia is as common as in China and the blind are consequently numerous. Infant mortality is great, though there is no rachitis. Children are nursed until the fourth year of age, the galactogenic powers of the mothers being remarkably pronounced. Kagawa,[48] a famous Japanese obstetrician, believed that the sex of the child might be known by the position of the fœtus, being male if on the left side and female if on the right.

Scurvy is common among the lower classes from bad alimentation, the chief diet consisting of rice and fish often spoiled. Leprosy and parasitic diseases of all kinds are frequent. Alcoholism is more general among the lower classes than in China, not because the race are greater consumers of *saké* (rice-spirit), but, probably because, as already stated, the opium-habit of the Chinese renders them more tolerant of alcohol.

The sudden transition of the social system of the Japanese from Oriental to Occidental methods has inordinately developed the nervous element, and mental alienation, to which like the Chinese this people is disposed, has assumed formidable proportions. Lycanthropy, among other forms of madness, already common enough in the country, has become much more frequent, and men and even women are met all over the Japanese islands, who believe themselves changed into dogs and foxes, and run about counterfeiting the voices and habits of these animals.

Dr. Hashimoto[49] of the Japanese Army states that cancer has existed among the Japanese from the most ancient times. The frequency of carcinoma of the breast among Japanese women is interesting because of the difference of dress between them and European women. The former wear no corsets nor any other article of dress apt to irritate or press upon the breasts, but do wear a broad soft band (*obi*) of cloth or silk around the body below the breasts, serving to support the abdominal walls. The uterus and tongue are frequent sites of cancer, but the lips rarely, which Dr. Hashimoto attributes to the different way of holding the pipe by the Japanese. Carcinoma of the œsophagus is common among *saké* drinkers, though it is not easy to understand how a mild liquor of this sort can occasion it.

In *New Caledonia*, as in the rest of Oceanica, alcoholism, syphilis and phthisis, all concomitants of the civilization, which a Christian nation has attempted to implant, are causing the disappearance of the aborigines. (Verrier.[50]) Numbering seventy thousand at the time of the French occupation, in less than half a century, the population has fallen to twenty-three thousand. Nevertheless, the half-breeds are vigorous and the females intermarry readily with the colonists.

The climate of New Caledonia is salubrious. As in other temperate regions, affections of the respiratory apparatus occur, but phthisis has found more victims since the advent of Europeans. Scrofula, which is common among the Melanesian race here causes numerous severe ophthalmias, blindness being frequent among the natives. Phagedenic ulcers are often seen, as are eczema, impetigo, erythema and leprosy. Notwithstanding the existence of marshes, there is no intermittent fever either among convicts or colonists, on these islands, which is also the case on other marshy islands in Oceanica, but that this is a peculiarity of the country and not of race is proved by the fact that Neo-Caledonians taken to Africa or Madagascar, succumb to fever as quickly as Europeans. On the other hand, negroes are almost wholly exempt from it both in their own country and elsewhere. Abdominal affections are not serious, but muscular atrophy and arthritis with heart complications are not rare. Intestinal worms are common and among nervous diseases, tetanus, chorea and demoniacal delusions.

Syphilis, while less frequent and grave than at Tahiti, is com-

mon enough, as evidenced by the number of children affected with constitutional syphilis. Frambœsia, the *pian* of the Negro race, is also seen.

Europeans newly arrived suffer from typhoid fever, diarrhœa, dysentery and phthisis, but hepatitis and splenic enlargements do not occur, and the dry colic of hot countries is equally unknown.

The entire absence of miasmatic influences is the characteristic of *Tahiti* as of New Caledonia. The Society Islands are favorably situated for the study of the effects of civilization during the fifty years they have been objects of the special attention of Europeans. M. Kergrohen,[51] surgeon in the French Navy, says that small-pox, measles, scarlet-fever and dengue have all been imported, and concerning lepra and elephantiasis, which have been so strangely cantoned in Oceanica, that while the former is frequent at the Marquesas, it is rare at Tahiti, the reverse being true of the other. Phthisis is rare and only fatal between forty and fifty, and is rather a result of diverse causes than of tuberculosis. Nervous diseases and insanity are extremely rare, and cholera and yellow-fever unknown. Europeans suffer from anæmia due to the little variety and insufficient amount of animal food. Here as in the other Pacific Islands, alcoholic excesses and syphilis are the most fruitful source of evil to the native population.

Fiji.—According to Dr. David Blyth,[52] the Fijian race forms a connecting link between the Malayan and Papuan inhabitants of the wide-spread Polynesia. Puberty occurs early, Fijian girls menstruating at ten. Catamenial irregularities and dysmenorrhœa are not unknown, which is not surprising inasmuch as they are guilty of gross indiscretions, such as bathing in streams and wading in the sea fishing during the menstrual period. Sterility is not uncommon and as a class Fijian women are not prolific, voluntarily inducing abortion to prevent large families. Although polygamists, promiscuous sexual intercourse was not the rule until their contact with civilization and the enforcement of a nominal monogamy. Pregnancy among Fijian women is not attended with the usual concomitants met with among European females, attacks of vertigo and loss of consciousness being the only disorders to which they are subject. Parturition is speedy and easy, although tardy and difficult labors occasionally occur, but there are really

no diseases incident to the puerperal state among them. Fijian mothers prolong lactation to the second or third year.

Captain Beechy says of the *Pitcairn Islanders*,[53] the descendants of the mutineers of the Bounty, and whose isolation has enabled them to maintain their simple and natural habits of life, that parturition seldom lasts longer than five hours, has never proved fatal and never been attended by twin births. Miscarriages occur only from accident. Infants are not weaned until three or four years old, and are exempt from teething and bowel complaints and from infantile eruptive diseases.

Hawaii.—The rapid spread of leprosy since its introduction in the Hawaiian Islands has accelerated the destruction of the native race begun by syphilis, small-pox and other imported eruptive diseases. Surgeon Woods,[54] of the United States Navy, states that the first native leper was recognized in 1848, but it was not until 1859 that leprosy was accepted as deeply rooted. In 1865, a temporary leper hospital was opened at Kaliki, near Honolulu, and in January, 1886, the leper settlement was formally established on the island of Molokai at which up to 1885, there had been 3076 lepers received, who are enumerated, as follow:—

Hawaiians,	2,997
Of mixed Hawaiian blood,	37
Chinese,	22
Whites (Germans 6, British 4, American 4, Pole 1, Portuguese 1),	16
Of other nationalities and acquired elsewhere,	4
	3,076

The natives strenuously opposed segregation, and up to 1876, there was a greater number at large than had been brought into the settlement. The largest number of annual admissions was 1847 in the year 1873, the smallest 51, in 1880. The white race is resistant of leprosy and by its habits of life opposed to those close associations with lepers which are necessary for the transfer of the contagion. Mixed Hawaiians are approximately classed by Dr. Woods as to resistance and modes of life with whites, and while the introduction of leprosy is due to the Chinese, the disease does not spread among this race on account of the horror with which those affected with it are regarded and the outcast life they are compelled to lead. Eradication can only be accomplished by bringing the lepers together in an isolated community. The generative power of the leper is feeble, births are comparatively few,

and the children are commonly still-born. Hawaiian women generally are outnumbered by men and are not prolific, only one in three having any children.

The Negro Race.—According to Dr. George Smith,[55] late senior medical officer of the Congo Free State, women in that country have small families, seldom more than two, and twin children are in all cases killed. There was more sickness and of a more serious type among the whites on the lower Congo from Stanley Pool to Banana at the mouth of the river than on the sea-coast or the upper river. The fevers were of a remittent type, simple, bilious and hæmaturic, intermittent forms being exceptional. The hæmaturic variety was not serious from losing blood, only the coloring matter appearing in the urine, but it was complicated with congestion of the larger organs, and in severe cases hemorrhage took place from all the cavities. Dysentery was rare on the lower river, but was increasing with the larger white population. The jigger or burrowing flea (*chique-chigoe*) was the only insect causing annoyance, and this attacked the feet and occasioned deep ulcerations.

Dr. Briggs,[56] of Nashville, Tennessee, states that negroes bear operations better than whites, but do not get well so rapidly and are prone to suppuration. Malformations are rare, but fibroids and fibro-cystomata common. Dr. Yandell,[57] of Louisville, Kentucky, declares that epilepsy is exceedingly rare in the negro—tetanus very common especially among the full blacks. He has never seen hare-lip in a negro, but keloid is frequent, and stricture of the urethra exceedingly common. Dr. Kinloch,[57] of Charleston, South Carolina, points out the mistake in classing all negroes together. As a rule the pure negro is not strumous, while mulattoes are. The pure negro bears operations well and recovers promptly and the liability to suppuration is less than in the white race. These views are substantiated by Tiffany, of Baltimore, after a study of nearly 5000 cases.

The Reverend Father Charles Croonenberghs, S. J.,[58] of the Zambesi mission, calls attention to a peculiarity of the natives of South Africa in their aversion to the use of water for external purposes during dry weather. They avoid bathing except during heavy rains, their idea being that frequent ablutions are debilitating and render them susceptible to malarial fevers and cutaneous erup-

tions. Father Croonenberghs obtained this information from Antoine d'Abbadie, of the Institute of France, and found it applicable in South Africa. They both observed its teachings and lived, while all those among their companions who sought relief in the free use of water died. The three who had, like them, abstained from its use, since 1879, still live. Instead of opening the pores by means of baths, the natives endeavor to close them, on the contrary, by the application of fats over the entire body.

Dr. Mattei,[59] of the French Navy, obtained surreptitiously at Ouïtcha, on the borders of the Niger, an idol composed of several roughly sculptured gods in two superposed rows, which is now preserved in the Trocadéro (Paris) Museum of Ethnography. It possesses a medical interest from having among the group of deities in the lower row a female figure representing a goddess in the parturient act and kneeling, which as Dr. Verrier[60] remarks, is the mythological posture of Latona, mother of Apollo. The negro goddess, a sort of Lacina of the Latins, has her arms elevated and seizes a horizontal bar above the head. The head of the child is as large as the mother's and like her has the face in front. Pregnant women offered prayers to this deity during gestation and after accouchement returned to give thanks after the fashion of the churching of Christian women and the purification practiced by Jewesses.

THE OUÏTCHA GODDESS.. (*Journal de Med. de Paris.*)

Surgeon J. J. Lamprey,[61] of the British Army, gives an account of three of the so-called "*Horned Men of Africa*," first described by Professor Alexander Macalister, of Cambridge. These were from different localities in Western Africa, were in no way related to each other, and were alike in their physical peculiarities, which consisted of a very remarkable congenital development of the infra-orbital ridge of both maxillary bones. The first was a Fantee, named Coféa, 32 years old, from the little village of Amaquanta in the Wassan territory. The skin over the maxillary

knobs was quite healthy and not abnormally stretched. The second was a long faced youth of eighteen, named Quassia Jabin, from the town of Bontooco, in the Gamin territory. The skin over the horns was normal, unattached, and there was no impairment of smell. The third was also a long-faced youth, Cudjo Danso, at Cape Coast Castle, aged about twenty. Dr. Lamprey had not observed this fullness in others and from inquiries made could not learn anything to confirm the statements that any large number of persons were to be found in Western Africa similarly affected or the conjecture that artificial means had been used to

HORNED MAN OF AFRICA; WASSAN TERRITORY.—(*British Med. Journal.*)

produce the deformity. In many negro skulls a kind of ridging of the zygomatic process of the maxilla may be observed, not reaching to the length of the brim of the orbit, but involving the bones of the nose and forming an exostosis of the maxillary ridge.

India.—Sanitary inquiry is causing India to lose much of its reputation as a hot-bed of disease for Europeans. Mr. Justice Cunningham,[62] while admitting that sickness and mortality rates in India are greatly in excess of those in England, contends that sanitary reform is possible which will reduce them as in other countries. He insists that there are no special ineradicable causes

of disease in India unknown to Europe and therefore, irremovable by European methods of prevention, the adoption of which would save India an enormous annual death-roll. Even cholera, so mysterious in origin and so erratic and deadly in course, is under the influence of sanitary measures. Surgeon Greamy,[63] of Chudderghat, in the Nizam's Dominions, says that cholera, dysentery, diarrhœa, and dracontiasis, (from bad drinking water,) prevail because local conditions conducive to their origin and development are present. Brigade Surgeon Curran[64] is of the opinion that the liver

HORNED MAN OF AFRICA; GAMIN TERRITORY.—(*British Med. Journal.*)

disorders of soldiers and others in India are largely due to over indulgence in animal food, rum and malt liquor, and Dr. George Harley declares that these factors, gluttony and intemperance, are not only the most common predisposing causes of idiopathic suppuration of the liver in India but elsewhere; these indulgences, in proportion to the habits of life, being far more common among Europeans in the tropics than among the same class of persons in temperate regions, and consequently that climatic conditions *per se* independent of over-eating and drinking have very little to do with the cause of the disease. Dr. Monat says in substance that most

Europeans consume more animal food and spirits than are good for them, and the influence of the great factor heat has been disputed by no less an authority than the late Dr. Parkes, who said, "The greater prevalence of the disease in the East than the West Indies has never been satisfactorily explained, hence there is perhaps but little connection between heat and liver disease. Dr. Cullimore[65] of the Indian Army asserts that a careful examination of the latitudinal distribution of hepatic abscess and attendant dysentery, shows clearly that it is far less frequent in the equatorial

HORNED MAN OF AFRICA; CAPE COAST CASTLE.—(*British Med. Journal.*)

belts beyond 6° and 7° N. and S. than in tropical zones, and reaches its maximum in low tropical regions between 7° and 18°, which are characterized by a well-marked wet and dry season, by periodical rains and great continuous heat, presenting in their greatest intensity the conditions most favorable to the predisposing factor of heat, combined in a high degree with the exciting factors of considerable variations of temperature associated with torrential periodic rains,—factors most favorable to chill, and particularly so, when taken in connection with the great preceding heat. This

region is well exemplified in the Madras Presidency, the seat of the greatest prevalence of hepatic disease. If we except the smaller tropical islands, such as the Andamans in the East and the Antilles in the West Indies, whose climate approaches that of the high seas, it will be found that the equatorial belt remarkable for its equability, for the absence of well-marked seasons, for constant as opposed to periodic rains, for a lower temperature than the low tropics, is less subject to hepato-enteric diseases than they. The small equatorial islands of the Dutch Archipelago, the Mollucas, Banka, Celebes and the Linggas, enjoy immunity, while in the larger, as Java, Borneo, Sumatra and New Guinea, it is comparatively rare and generally confined to the hill-slopes. It becomes more common in the Philippine Islands and particularly in the northern and large island of Lazon bordering on the Tropic of Cancer. Southern (French) Cochin China, peninsular in form though subject to fever so virulent that European children born in the country seldom survive, suffer little from hepatitis and dysentery, while in Tonquin, bordering on China and exposed to periodic cold winds from the northern hills, these scourges are remarkably prevalent. In Southern China it is not uncommon, while in Burmah and Lower Bengal, particularly along the river valleys subject to inundation it attains its maximum. The portions of India, which enjoy the greatest freedom are Scinde and the Punjaub sub-tropical regions, characterized by a very dry climate, a long and bracing cold season, and as regards the Punjaub, subject far beyond all other parts of India to endemic febrile disease. In Ceylon, Persia and Arabia it is a rather common disease, while in Bombay its greatest prevalence would appear to be on the slopes of the lower hills. In Africa and America the same distribution holds good. Thus, it prevails in Egypt and Sennaar, while it is almost unknown in Zanzibar, Lat. 6° S., where fevers are virulent. On the west coast of Africa, hepatitis prevails in its greatest intensity in Senegambia, Lat. 8° to 16° N., causing one-third of the deaths from all causes and including dysentery one-half. Proceeding southward, it is met with but less frequently, and nearer the equator about the Gaboon and Niger is a rare disease. It is rare in Nubia, a dry region not unlike the Punjaub. Stanley draws attention to the greater salubrity of the equatorial stations of the upper Congo, as compared with those nearer its mouth, but farther

removed from the equator. It is also the opinion of Dr. George Smith,[66] late senior medical officer of the Congo Free State, that there is more sickness and of a more serious type among the whites on the lower Congo, than on the sea-coast or upper river. Subtropical Algiers, a country of terraced hill-slopes, suffers considerably from hepatic disease, and Cullimore attempts to show here, as elsewhere, a certain antagonism between it and malarial fever. The influence of the original habitat of the emigrant is illustrated by the immunity which southern Frenchmen, Spaniards and Maltese enjoy as contrasted with Germans, Normans and British.

In America, hepatic abscess is especially common in Chili, a temperate region, and along the coasts and forests of Peru, fully one-third of the deaths being caused by affections of the liver. In equatorial Brazil, especially at Pernambuco and Bahia, severe dysentery is exceedingly rare, but at Rio, just within the Southern Tropic of Capricorn it is more common. In Central America, it again becomes common and is not unusual in Mexico. It is rare in the Southern States, as at New Orleans, and is almost unknown in Florida. While not uncommon in Cuba and San Domingo, it is rare in the smaller West India islands, especially in the Bahamas.

Among the flesh-eating Australians it seldom occurs unless in connection with hydatid, and is almost unknown among the islands of Oceanica, excepting the comparatively extensive New Caledonia, where it has recently appeared.

Dr. Cullimore's deduction from the broad geographical distribution of abscess of the liver in hot climates, in which it is invariably directly associated with dysentery, and where it occurs in inverse proportion to ague, is that while great and continuous heat is the most powerful predisposing cause, and after heat intemperance, that chill, the result of seasonal and accidental variations of temperature, of heavy rains following dry hot seasons, of fluvial inundations so favorable to wettings of the body, is the main exciting one; and as in all these countries, the dietary and habits, especially of soldiers, who furnish the greater part of the statistical information, are similar or identical. Dr. Harley's opinion that climatic conditions *per se* have little to do with causing the disease, deserves reconsideration.

According to M. Van der Burg,[67] of Leyden, all Europeans

succumb to the influence of the climate of the Indies, but ordinarily end by becoming acclimated. The change of diet is, along with the alien climate, a potent morbific factor. The European loses appetite and the insipid food of the natives being distasteful, he resorts to stimulating condiments. Most diseases in the Dutch Indies are complicated with anæmia. Change of residence to cooler localities or to higher altitudes is not alone sufficient remedy. Complete recovery only follows a return of the invalid to his own country, and nervous diseases are frequently benefited by the sea-voyage alone. Malaria, complicated or not with glycosuria, dysentery and hepatitis, require return home for their cure. With syphilis, beri-beri and phthisis, which are common in the Dutch Indies, this is less necessary. Dr. George Thin,[68] a Dutch physician of Batavia, describes an affection, which is there frequent, and which he terms *Psilosis* or *Indian Sprue*, as an idiopathic disease, never epidemic, passive, chronic, non-contagious, attended with peculiar abrasions or excoriations of the mucous membranes, and terminating fatally from exhaustion.

Venereal diseases in every form are among the chief curses of Bellany,[69] and Surgeon-Major E. Lawrie,[70] of Hyderabad, says that syphilis prevails in the Nizam's dominions in the most severe form, phagedenic ulcers and sloughing of the genitals occurring early in the disease, and that it has the most disastrous effects on the health of the reputable classes of women, thirty per centum of whom become objects of indirect infection. Abortion is a common and unconcealed practice among married women, with whom it has no criminal character. The Vital Statistics of the Khasi tribe show that the female population outnumbers the male, a condition almost unique in India. More boys are born than girls and men have better lives than women between twenty and thirty years of age, but the larger mortality among boys in infancy and childhood and among men after middle age restores the balance in favor of women.

Persia.—Dr. Joseph P. Cochran, Ooromiah, Persia, Corresponding Editor of the ANNUAL, states that the ordinary Persian dectors have incorrect ideas of anatomy, dissection not being permitted. They recognize certain natural laws, which are required to be observed by every practitioner and are known to ordinary people as well. The food on entering the stomach is supposed to

undergo a preliminary digestion, separating it into a semi-solid portion, which passes off as waste water, and a liquid part, which goes to the liver, where a second separation takes place, one part going to the kidneys and thence to the bladder as urine, the other remaining to undergo a thorough metamorphosis, or as they term it distillation, of which the result is the separation of the contents of the liver into the four new substances or humors, blood, bile, phlegm and *sodow* (for which there is no English equivalent). These differ in density and weight and lie in different layers in the liver, the *sodow*, being heaviest, gravitates to the bottom, and is carried to the spleen; the phlegm, the next in density resides in the lungs; blood, the third, goes to the heart and thence over the entire body; the lightest, bile, goes to the gall-bladder. The spleen, lungs, heart and gall-bladder are thus the receptacles of these four humors, which all circulate more or less with the blood, and if one or more are in excess, sickness must follow. An excess of *sodow* (the black bile of the ancients) will produce any of the skin diseases; too much phlegm loss of muscular and nervous power, hence all the neuroses; excess of blood produces inflammation and congestion; and of bile, headache, vertigo, amaurosis, etc. Dr. W. Norton Whitney[71] states that Japanese physicians also believe in different spirits (*ki*) the derangements of which in the body cause disease. In the *San-ron*, a Japanese work on midwifery, it is stated that in case of abortion during the first three months of gestation, the entry is round and if cut in two shows five colors, thus conclusively proving that the human body is the true essence of the five elements, water, fire, metal, wood and earth. Examination of the pulse, tongue, countenance, taste, urine, and the kind of food craved informs the Persian physician as to which of the humors is the cause of the disease. If the pulse be strong and rapid, the taste of the mouth sweet, the tongue red, the urine reddish, the countenance flushed and the patient has a desire for warm and wet food, blood is the morbific cause; if the pulse be strong but slow, with lack of taste, the tongue white, urine colorless, face pale and craving for cold and wet food, phlegm is in excess; if the pulse be small and slow, the taste salty, the urine dark, the countenance dark, with an appetite for cold and dry food, *sodow* is to blame; if the pulse be small and rapid, the taste bitter, the tongue yellow, the face and eyes yellow, the urine greenish

and warm and dry food be desired, bile is in excess. The Persians believe there are four elements, earth, air, fire and water, and that these elements have each two characters; thus, earth is said to be cold and dry, air warm and wet, fire warm and dry, water cold and wet. *Sodow*, in respect to its characters, is, like earth, cold and dry; blood, like air, warm and wet; bile, like fire, warm and dry; phlegm, like water, cold and wet. It follows that all kinds of food and drink being compounded of one or two of these elements must have also their corresponding characteristics, but the classification is arbitrary, for sugar is warm and dry while honey is warm and wet, beef is cold and dry, mutton warm and wet. If a case be found to have bile in excess, which being warm and dry, in the system, some medium which is cold and wet must be given and the food likewise have the opposite characters of the humor which is the excess.

According to M. Geiger, puerperal fever was included among the fevers known to the ancient Eranians. Among the 4333 maladies described in the Avesta are venereal diseases, according to Casartelli, and leprosy according to Geiger was an Eranian disease, confirming Verrier's[72] statement that this malady had its home in all the region comprised between Asia Minor, the Persian Gulf and the high plateaus of Central Asia, especially in the vicinity of Teheran where whole villages are to be found entirely peopled by lepers.

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HYGIENE AND EPIDEMIOLOGY.

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WASHINGTON.

GENERAL CONSIDERATIONS.

The study of hygiene has engaged the attention of mankind from the most remote period, not only with the view of prolonging individual life, but as well to increase the effectiveness of armies by preserving their health, and to secure commercial advantages from infant colonies, by planting them in salubrious places, where their growth and development would be least retarded by inhospitable surroundings; but as time has advanced and population steadily increased, this noble science has been comparatively neglected, and it is only in modern times that the art of prolonging life has become an important care of all States.

In this enlightened age, it is fully recognized that the welfare of the individual is the welfare of the nation; notwithstanding the Malthusian theory that the natural course of contagious disease and epidemics should never be checked, as they prevent overcrowding and prove the rule of "the survival of the fittest." If the vicious, the pigmies, the deformed and those otherwise hopelessly diseased were alone attacked, some sort of solace could be extracted from the contemplation of a widespread epidemic; but, unfortunately, there is no discrimination. When a contagious disease makes its appearance, all are alike subject to its fearful influence; and while it is probably true that the weakest soonest succumb, yet the vast number of the strong who must fall in such calamities show the fallacy of assertions of this kind.

In the work of the sanitarian, the general public is growing every day more and more interested, and more in sympathy with the movement to prevent disease and prolong human life.

THE ENVIRONMENT OF MAN.

1. *Light.*—Lavoisier announced many years ago that without light, nature was without life and would remain dead and inani-

mate. Moleschott says that all existing things are given life and movement by the light of the sun. Fazio[1] refers to the well known example of exposing to the sun, in a white glass tube, some water freshly drawn from the well. Soon the water grows green in the bottle and becomes a reservoir of watery threads and green infusoriæ. These simple forms of active life cannot be developed outside the action of light; hence the water of a deep well, being deprived of light, usually remains uninfected by infusoriæ, and while it is admitted that the rays of the sun do not act in the same manner on all organic bodies, there is no doubt as to the unanimity of opinion regarding the general chemical action of the rays of the sun. Special peculiarities of plants are lost by deprivation of light; for instance, perfume bearing plants lose their odor when put in the dark, and only regain it when again subjected to the sun. The experiments of Moleschott have proved, also, that light favors the nutritive functions of animals, while darkness retards them. Pflüger proved that even the bones are directly passed through by the luminous rays, and Fubini and Ronchi show that the exhalations of carbonic acid through the skin of man, as well as frogs, is greater in the light than in the dark. It has been asserted, too, that colors are more vividly produced in hair in summer than in winter. This, however, does not seem to be borne out by the experiences of the Northwestern trappers, who are always careful to secure winter skins, not only because of the hair being full grown, but also because of the brilliancy of its color.

When the solar spectrum is divided into its separate rays it is seen that all rays have not the same physical powers. The distinctively luminous rays, the yellow and orange, act directly upon plants as well as animal life. The experiments of Pleasanton seem to have proved that young plants grow most luxuriantly under the influence of the blue rays.

On man it is seen that the effects of light are principally noted on the eye, and through it on the nerve centres, thus producing images and sensation. Such being the general physiological effects of light, it may readily be understood that light, wrongly regulated in quantity—excessive on the one hand or insufficient on the other—produces pathological effects. This is seen in the production of various diseases of the eye, such as the retinitis following excessive

light (snow-blindness), and extreme dilatation of the pupil, with super-sensitiveness of the retina when the light is too feebly admitted. While solar light is thought best fitted for the uses of man, yet for the ordinary purposes of life this is replaced by artificial light, produced either by the combination of solid, liquid or gaseous substances—such as candles, tapers, antique or modern lamps, lamps for petroleum, illuminating gas, and electric light. According to Fazio,[2] the intensity of the effect derived from the artificial light is in the ratio of the horizontal projection of its rays and the simultaneous action of the direct and deflected rays on the eye. The shape of the cornea and the focal distance of sight is very much altered from the normal standard in persons who work in badly lighted rooms. The question of lighting must be studied, first, from the standpoint of illumination, second, the inconvenience of the particular artificial light under consideration, and third, the toxic effect of such light, either by the exhaustion of the oyxgen in the ordinary process of combustion, or in the giving off of gases.

The first class of these lights seems to have received but little attention during the past year, but as the electric light becomes more and more used on account of its great advantages, its effects are beginning to be studied with more care. Dr. G. Sous,[3] in an elaborate communication to the Society of Medicine and Surgery of Bordeaux, combats the following proposition, which had been raised by Dr. G. Martin: "When one compares the ocular accidents caused by the sun with those engendered by electricity, one is struck by their great similarity. The effects of the sunlight, direct or reflected, are the same on the eyes as those from electric lights." He cites the well known observations of Demours and Sichel, the former of whom made more than twenty observations of incomplete amaurosis supervening upon the eclipse of the sun, September, 1820; and Sichel the cases of five persons who were attacked with amblyopia, some of a chronic nature and others irritated after having for too long a time gazed on the eclipse of 1836. Between the time when the eclipse was examined and the commencement of their visual troubles, there was a variable period of a few minutes in some cases, and in others of some hours. With the subjective symptoms noted, the affected persons also suffered from obscurity of vision, while the perception of colors was also

affected. As to the duration of the malady, it is impossible, says Sous, to assign its limit; the disease persisted for months or years, and sometimes was prolonged through life. Its progress was slow, and in fact chronic from the first day.

A number of cases are cited from Rognetta, Larrey and Jaeger. Passons maintains that all these accidents may be produced by the electric light, but in order to produce them, it was necessary to place the subject under the identical conditions. This was also necessary to establish a comparison between the direct action of solar and artificial light on the eye. He found that between the moment of the cessation of the electric light and the moment the disease commenced, there was a time tolerably constant. Emrys Jones placed it at six to eight hours. In fact, the subjects of the ocular affection had retired without suspicion of ocular trouble, but during the night were wakened by pain, more or less intense. The pain, the photophobia, the blepharospasm, were the prominent symptoms. The disease became acute, and rapidly attained its greatest intensity, lasting for some days, and usually terminating in recovery. It will be seen, says Sous, that these symptoms in the two do not present much resemblance. Their progress, duration and termination, all differ. The same cause could not give birth to phenomena so variable.

The accidents produced by the eclipses of the sun recall the experiments of Czerny on insolation of the retina. Those produced by the electric light, on the contrary, approach those symptoms which the ancients called scrofulous photophobia, and which savants to-day call a lesion of the nerves of the cornea. The solar light, therefore, produces deep affection of the eye, the electric light, superficial affection. This difference exists, not alone in pathology, but also in the physiological effects.

Georges Martin[4] has made a study of the electric lighting of theatres, and affirms that the period of tentative study and experiment has passed, and that the electric light should be adopted in all theatres for the purpose of preventing destructive fires and consequent loss of life, if for no other purpose. For producing a brilliant light without the many inconveniences and toxic effects of other illuminating agents, nothing is comparable to electricity. It is the ideal theatre light.

The causes of vitiation by illuminating gas are three:—

1. The gas itself escaping, mingling with the atmosphere, unconsumed.

2. The transformation by its combustion, into certain offensive products,—sulphur, ammonia and carbonic acid.

3. The combustion of sulphur producing vapors of sulphurous and sulphuric acid, which are extremely irritating. The ammonia does not burn, except with a very bad flame or with Bunsen burners, and then it forms the cyanide of ammonium,—a salt volatile and poisonous. The carbonic acid gas is not entirely consumed, even when the burners are well constructed, except in the Argand.

4. The illuminating gas not only throws into the air those poisonous fundamental elements of combustion, but it increases the amount of carbonic acid present in the room, which is already an enormous volume by reason of the respiration of the spectators. Moreover, each burner exhausts, in the process of combustion, a large amount of the oxygen. Martin quotes the observations of Pettenköffer, in 1883, who found that in one gallery in a certain theatre, in about an hour's time, there was one per cent. increase of carbonic acid gas during the use of illuminating gas, while in the same period there was only 0.1 per cent. and 0.96 while electric lights were used.

The researches of Renk are quoted, which were made in the Grand Theatre of Munich, lighted by 1400 Edison lamps. He proved that gas augmented considerably the proportion of carbonic acid in the atmosphere, while electric light gave no augmentation; also that the heat disengaged by combustion of gas was enormous, while that resulting from electrical light was infinitesimal.

Laurbe demonstrated that the voltaic arc disengages 150 to 200 times less heat than illuminating gas from burners. Guerout in his experiments gave the same results.

A communication made to the Society of Electric Engineers of London, by M. Crompton indicated the results of his observations made in a room containing 311 persons. The room was lighted by gas, and the temperature was raised in three hours from 15.5° centigrade to 37°. With the electric light, the elevation of the temperature after seven hours was only one degree. The quantity of heat due to the combustion of gas was equivalent to that which would result from the presence of more than 4000 persons.

Dr. Martin insists that the electric light, by the nature of its luminous radiations and its intensity, is the only artificial light which approaches natural light, and that, like the light of the sun, it contains all the colors of the spectrum. He claims that the uniformity of the light in a room has been of great relief to the frequenters of the Théatre Lyrique at Paris, where it has supplanted other lights. By a proper arrangement of reflectors, the light does not seem intense in one place and feeble in others, but on the contrary, is uniform throughout the room. M. Hartmann, at the Vienna Medical College, stated that the progress made in the last few years in the lighting by gas and electricity had greatly contributed to diminish the dangers of the several systems of lighting, and that these dangers now depended principally on the manner in which the results of modern technic science were carried out; that a minute inspection and constant surveillance was absolutely necessary; and that when either system was well executed, the two were equivalent. To prevent fires in theatres, he thinks that in the spaces between the scenes, gas should be interdicted and the adoption of the electric light insisted upon. Hydrogen gas, by reason of its toxic qualities, should be absolutely proscribed for the lighting of habitations. Its employment could be tolerated for certain industries, provided proper precautions were taken.

Concerning the lighting of gas burners, an electric appliance has lately been adopted to prevent accidents from turning on of gas.[5] By a fixture connected with the gas jet, a spark of electricity is sent across the gas current and lights it. The gas must be turned on by pulling a chain, which at the same time causes the spark to pass.

Dr. Ecklund,[6] of Stockholm, in an article on poisoning from illuminating gas, has found many cases of intoxication from this source. In an almshouse in the parish of St. Catherine's in Stockholm, six pensioners were fatally poisoned. An examination of the illuminating gas of Stockholm, showed that it contained 8 per cent. of carbonic oxide.

The subject of poisoning by hydrogen gas will be again adverted to under the heading of Heat.

II. *Heat.*—The vital processes of living things require for their perfect action a certain temperature, nearly constant within

certain limits, and varying with each class. Even the lower forms of life, such as bacteria, are destroyed by very low or very high temperatures. Dr. Prudden, Director of the Laboratory of the Alumni Association of the New York College of Physicians, in an article on bacteria in ice, has given in substance the following summary on the effects of low temperatures on pure cultures of bacteria suspended in water.

Experiments so far on the action of low temperatures for long periods upon bacteria suspended in water show,—

First, that a large number of bacteria are killed by freezing.

Second, that the number killed depends upon the amount of vitality possessed by the individual. If the vitality is reduced by exhaustion of nutriment in the culture or drying, a large number of these bacteria will be killed; while when the conditions are favorable this will not be the case.

Third, the amount of resistance to destruction depends in a great measure upon species. Some species are completely destroyed by exposure to freezing for a short time. Others are capable of growth after long exposure, and it is almost impossible to destroy them by this process. The typhoid bacillus resists freezing temperature for a long period; and this is of special importance with reference to the destruction of this germ.

Fourth, the period of time in which low temperature is kept up is very important, as determining the number of bacteria of all species which will be destroyed. It seems that experiments go to show that after the first freezing, when the greatest destruction occurs, the more gradual death of the bacteria follows as time goes on. The limits of this gradual destruction has not been shown.

Fifth, these experiments show that all individuals are not capable of resisting the effects of low temperature equally. In any given culture the resistance of individual bacteria vary greatly. This is probably a result of massing and position.

Sixth, freezing and thawing alternately destroy bacteria more effectually than a freezing temperature kept up for some time; as, for instance, if the freezing temperature be maintained in water, and the water not allowed to freeze, the destruction of bacteria will be very great. Artificial tests with bacteria to determine their period of existence are much more severe than where they are

exposed to adverse circumstances in rivers and lakes, the changes of temperature being more sudden and more severe.

Dr. Henry B. Baker,[7] of the Michigan State Board of Health, in a recently published abstract of his researches into the causation of pneumonia, finds that certain meteorological elements are so uniformly associated with pneumonia as to make it appear that they have a meteorological relation to that disease. This conclusion he arrives at after a long study of the meteorological conditions for a series of years, together with the varying prevalence of pneumonia. Among other things, Dr. Baker believes that the temperature of the air governs, to a great degree, the other meteorological conditions, and is the main factor to be taken into account. The charts which he has constructed show a very close relation between the average temperature and sickness from pneumonia; and the curves representing sickness from pneumonia follow uniformly at such a period after the temperature occurs, as to make it seem certain that the sickness is directly or indirectly caused by comparatively low temperature.

In a series of experiments on guinea pigs, Vinay[8] submitted pathogenic germs to the temperature of 118° C. The following cultures were used:—

1. A culture of blood containing bacilli and spores dried on linen, flannel and cloth.

2. Part of the same culture enclosed in the extremity of a glass pipette.

3. A dried virus of true charbon diluted with water and dried on fragments of linen, flannel or cloth.

4. The same virus enclosed in a glass pipette.

On the next day, some water was mixed with these cultures, and a cobaye was inoculated with the contents of the first pipette, and a test tube of bouillon was fecundated and a guinea pig inoculated. With the contents of the second another guinea pig was inoculated. Three inoculations showed that all the tissues yielded on the 31st of January, and the 1st of February, respectively, all the microscopic lesions of the charbon fever. The fourth cobaye inoculated with liquid from the pipette survived, this liquid remaining sterile. Consequently the culture exposed to the heat in a liquid state alone, was destroyed. The four cobayes inoculated with the virus of true charbon all died in the ordinary way.

In his second experiment, he exposed the same virus in like manner to a temperature of 130° C., and in this experiment of the four cobayes, two died. These were the ones inoculated with the virus dried on flannel and the one inoculated with the virus heated on a pipette. MM. Arloing and Cornevin[9] exposed fresh charbon virus to air heated to 100° for twenty minutes and the same virus, contained in a closed tube, was plunged into boiling water at 100°, becoming inactive in about ten minutes. Consequently, it was seen that the action of hot water is ten times as strong as that of hot air, even at the same temperature.

After a long series of experiments, they arrived at the following conclusions, which were unanimously adopted by the Société Médico-Chirurgicalé, of Lyons:—

1. The action of steam under pressure, is absolutely efficacious between 112° and 115° C. It destroys the most resistant germ after an application lasting 15 minutes.

2. Hot air and superheated steam are of less value; even at 130° C. certain germs escaped their influence when the application of heat was prolonged for 20 minutes.

3. The different tissues of linen, hemp, cotton and wool, exposed to repeated trials of disinfection at raised temperatures present gradual losses in weight, and the disinfecting power of the two forms of heat is equal. The consumption resulting from disinfection alone is very little when the temperature is not raised above two degrees, even after six consecutive passages through the stove.

4. The only serious inconvenience is in the disinfection of the linen when it is soiled by colored matters, as blood or fæces. This inconvenience exists constantly. Whatever may be the form of heat employed, it appears that as soon as one exceeds 100° C., one approaches the necessary degree for the destruction of the resisting forms of the micro-organisms.

Electrical heating stoves[10] are being introduced into France for the purpose of preventing the noxious effect of the distribution of gases set free in the air by the combustion of coal. The feature of the construction of these stoves is that the wires are let through apertures formed in plates of refractory clay and plumbago. These plates are not enclosed, but are left exposed so that the air can circulate very freely through the aperture where

it comes in contact with the red hot wire. Wire bobbins are inserted in the apertures, each bobbin forming part of the electric circuit, and all being connected for quantity. The bobbins are heated by the passage of the current, and heat the air as it passes over them.

In connection with the subject of carbon mon-oxide being produced from combustion, Allan Macdonald[11] has pointed out that under certain atmospheric conditions, the carbon mon-oxide was deflected from the chimney top and entered the room through the window. He cites a case of sickness, in which the diagnosis was extremely difficult until the physician traced a defect in the flue of the furnace, and the connections of the smoke pipe with it, when the case was found to be one of poisoning from carbon mon-oxide.

Grehant,[12] of the Paris Academy of Medicine, gave the results of some experiments on the blood of animals that had been shut up in a closed space with a stove without a chimney, in a glass chamber, having a capacity of 10 cubic metres. The animals died in about an hour and a half, and the necropsy showed the characteristic signs of poisoning by carbonic oxygen. In his opinion movable stoves should be required, by regulation, to have a connection with the chimney. Stoves for illuminating gas, without chimneys, also produced intoxication. A healthy dog was shut up in a chamber of 10 metres capacity, with a gas stove. In three hours, the temperature of the chamber had risen from 9 to 16. Two hours after the introduction of the animal, a second extraction of gas from the arterial blood gave 34.4 carbonic acid and 12.4 of oxygen. Seven hours afterward, the same examination gave the same volume of carbonic acid, but only 10.6 of oxygen.

M. Grehant's views meet with favor by the Editor of the *Boston Medical and Surgical Journal*, who states that "one gas stove consumes more oxygen than a dozen men. These stoves are made both with and without stove-pipes for connection with a chimney, and they can be used in rooms having no connection with a chimney. Their effect upon the air is bad enough in either case and in the latter positively dangerous. A certain firm in one of our cities, advertising such stoves, states as one of their advantages, that they can be used either with or without the stove-pipe connection. To us, the possibility of using such stoves without the

stove-pipe connection should be reason enough for condemning them."

In connection with the subject of heat, we make the following extract from Dr. Parson's Annual Report of the Medical Officer of the Local Government Board for 1884,—as summarized in the *Medical Chronicle*:—

"1. Experiments on the penetrating power of dry heat and of steam showed that dry heat penetrates very slowly into bulky and badly conducting articles, as of bedding and clothing; the time commonly allowed for the disinfection of such articles being insufficient to allow an adequate degree of heat to penetrate into the interior.

2. Steam penetrates far more rapidly than dry heat, and its penetration may be aided by employing it under pressure, the pressure being relaxed from time to time so as to disperse the cold air in the interstices of the material. In hot air the penetration of air is aided by the admixture of steam, but hot, moist air did not have a greater destructive effect upon spores of anthrax bacilli than dry heat.

3. Scorching begins to occur at different temperatures with different materials, white wool being soonest affected. It is especially apt to occur where the heat is in the radiant form. To avoid risk of scorching, the heat should not be allowed to exceed much 250° F., and even this temperature is too high for white woolen articles.

4. By a heat of 212° and upwards, whether dry or moist, many kinds of stains are fixed in fabrics so that they will not wash out. This is a serious obstacle in the way of employment of heat for the disinfection previous to washing of linen, etc., soiled by the discharges of the sick.

5. Steam disinfection is inapplicable in the case of leather, or of articles which will not bear wetting. It causes a certain amount of shrinkage in textile materials, about as much as an ordinary washing. The wetting effect of the steam may be diminished by surrounding the chamber with a jacket containing steam at a higher pressure, so as to superheat the steam in the chamber.

6. For articles that will stand it, washing in boiling water (with due precaution against re-infection) may be relied on as an efficient means of disinfection. It is necessary, however, that before

boiling, the grosser dirt should be removed by a preliminary soaking in cold water. This should be done before the linen leaves the infected place.

7. The objects for which disinfection by dry heat or steam is especially applicable, are such as will not bear boiling in water, *e.g.*, bedding, blankets, carpets and cloth clothes generally.

8. The most important requisites of a good apparatus for disinfection by heat are (*a*) that the temperature in the interior shall be uniformly distributed; (*b*) that it shall be capable of being maintained constant for the time during which the operation extends; and (*c*) that there shall be some trustworthy indication as to the actual temperature of the interior at any given moment. Unless these conditions be fulfilled, there is risk, on the one hand, that articles exposed to heat may be scorched, or on the other hand, that through anxiety to avoid such an accident, the opposite error may be incurred, and that the articles may not be sufficiently heated to insure their disinfection.

9. In dry heat chambers, the requirement (*a*) is often very far from being fulfilled, the temperature in different parts of the chamber varying sometimes by as much as 100.° This is especially the case in apparatus heated by the direct application of heat to the floor or sides of the chamber. The distribution of temperature is more uniform in proportion as the source of heat is removed from the chamber, so that the latter is heated by currents of hot air rather than by radiation.

10. In chambers heated by gas, when once the required temperature has been attained, but little attention is required to maintain it uniform and in the best made apparatus that is automatically performed by a thermo-regulator. On the other hand, in apparatus heated by coal or coke, the temperature tends to vary, and can only be maintained uniform by constant attention on the part of the stoker.

11. In very few hot-air chambers did the thermometer with which the apparatus was provided afford a trustworthy indication of the temperature of the interior; in some instances there was an error of as much as 100° F. This is due to the thermometer, for reasons of safety and accessibility, being placed in the coolest part of the chamber; and to the bulb being enclosed for protection in a metal tube which screens it from the full access of heat. The

difficulty may be overcome by using, instead of a thermometer, a pyrometer actuated by a metal rod extending across the interior of the chamber.

12. In steam apparatus the three requirements above mentioned are all satisfactorily met, and for this reason, as well as on account of the greater rapidity and certainty of action of steam, steam chambers are in my opinion greatly preferable to those in which dry heat is employed.

13. Without wishing to give the preference to one maker over another, I may mention that of the apparatus heated by coal, Bradford's newer machine; of those heated by gas, the Nottingham self-regulating disinfecting apparatus; and of those employing steam, Lyon's patent steam disinfector, in my experiments gave the best results of any in their respective classes.

14. It is important that the arrangement of the apparatus, the method of working, and the mode of conveyance to and fro should be such as to obviate risk of articles which have been submitted to disinfection coming into contact with those which are infected."

Experiments on the action of heat as destructive of bacteria, during the year, have resulted in the following conclusions:—

"1. Bacteria free from spores cannot withstand an exposure of one and a half hours to a temperature a little over 212° F. in hot air.

2. Spores of mildews require for destruction a temperature of 230°–239° F. for an hour and a half.

3. Spores of bacilli are only destroyed by remaining three hours in hot air at 284° F.

4. In hot air the temperature penetrates so slowly into articles to be disinfected that after three or four hours' heating to 284° F., articles of moderate dimensions,—*e.g.*, small bundles of clothes, pillows, etc., are not disinfected.

5. By the heating for three hours to 284° F., necessary for the disinfection of such objects most materials are more or less injured.

The result obtained with steam were strikingly superior to those with dry heat. It was shown that an exposure of five minutes to steam at 212° F., was sufficient to kill the spores of the anthrax bacilli, and one of fifteen minutes to kill those of the bacilli contained in garden earth. Moreover, the penetration of

the heat into articles exposed to steam took place far more quickly than into the same articles when exposed to dry heat.

Effects of Heat on the Human Body.—In the consideration of the effects of heat upon the human body, we must take into account the production of caloric by the chemico-physical force of the body itself, which modify the effects of the environment; and these modifications must be studied in the changes produced in pulmonary respiration and cutaneous radiation and transpiration. This will be adverted to under the heading of air. The direct effects of the heat of the sun upon the human body are best seen in the frequent cases of sunstroke among the French and English troops in Africa and India.

In an article entitled "Heat Stroke in India," by John Anderson,[13] the following division, embracing the various forms of the disease, are given:—

(1) Ardent fever; (2) heat apoplexy; (3) sunstroke.

He says: "Such a classification seems to me more fully in accordance with the deviation from the normal temperature of the blood; the effect varying not only in relation to the height of the temperature reached, but also in relation to the rapidity with which it is reached." He goes on to say: "By *ardent fever* I mean a non-specific continued form of fever, of comparatively short duration, resulting from exposure to heat.

"*Heat apoplexy* is a heat fever, with a high temperature, contracted pupils, cyanosis, loss of consciousness and a marked tendency to death by asphyxia. It more commonly results from the *indirect* effects of solar heat, or radiated heat, and usually occurs at night, in dwellings or in crowded tents.

"*Sunstroke* is a form of heat fever, with a very high temperature, contracted pupils, rapid loss of consciousness, and frequently attended with convulsions indicative of perverted action and exhaustion of the nerve centres."

With regard to the prophylactic measures of treatment he says:—

"People who live, and soldiers who serve, in hot climates cannot get rid of heat; but they can do much to modify it by living in well ventilated rooms, with a suitable proportion of cubic space and superficial area for each occupant. They can make the still air move by means of fans or punkahs. They can be temperate

both in eating and in drinking. Most particularly they can abstain from alcohol, or take it only sparingly, and well diluted with water, for alcohol has a powerful deleterious influence because (1) it increases portal congestion, and (2) it has a great attraction for water. They can clothe in garments that are light both in color and in weight and are loose enough to admit of the freest respiratory movements."

In the debate on the papers, Deputy-Inspector-General W. H. Lloyd made the following remarks:—

"Heat stroke is not ordinarily a frequent disease in the British Navy; but there is a yearly percentage of death from this cause, and ninety per cent. of these cases occur in the Red Sea, on ships passing through the excessive high temperature usual in this region at certain seasons. These cases are almost without exception cooks, saloon stewards or bakers, and occasionally stokers; rarely is a blue jacket, or a man working on deck, a victim. The classes mentioned generally spend much of their time in close, ill-ventilated, hot places, and are often addicted to unwholesome living and alcoholic excess. They are generally a flabby and etiolated class, and are rarely in a high condition of health."

Surgeon-Major Langridge, during the debate, said:—

"While in India I had some experience in the injection of the neutral sulphate of quinine. My cases were not those of sunstroke, but of very severe cases of remittent fever, accompanied by extreme high temperature. Ordinary remedies, including the administration of large doses of quinine internally, failed to reduce this to any extent. Hypodermic injections, three or four times daily, were then adopted, with great success; and in no case was there a more severe after-symptom than the occurrence of a slight local induration."

Dr. T. H. Sherwood, Medical Examiner U.S. Pension Bureau at Washington, D.C., said:—

"I have had the opportunity in the Pension Bureau with which I am connected to study the after-history of these cases, and in the great majority of them have found that the heart is involved, and that we have hypertrophy, dilatation, and sometimes valvular disease."

Dr. Anderson, in closing the debate, said:—

"I should like to say, in reply to Dr. Wood's remarks, that I

regard it as a matter of course that no means of reducing body heat, such as ice and cold affusion, should be neglected: but I especially drew attention to the subcutaneous use of quinine because it is both the most powerful and the most rapid agent for this purpose with which I am acquainted. To antipyrin and antifebrin I have referred but very briefly, because I have no experience of these agents in these cases. Referring to the blood-letting mentioned by another speaker, I may remark that such practice was at one time very general in India, and the resulting mortality was so great that it was given up."

From an article entitled "De l'Acclimation des Européens dans les Pays Chauds," by Dr. Treille,[14] the following summary of the effects of heat in hot countries is given:—

1. Augmentation of pressure in the portal system, predisposing to congestions of the liver.

2. Augmentation of the volume of blood in the general circulation, characterized by vascular plethora, dilatation of capillaries (cutaneous, visceral and hydremic veniosity of the ancient authors), acceleration and amplitude of the pulse at the beginning of acclimation.

3. Tendency to anæmia by rupture of the connection between the globules and the serum (serous-anæmia).

Finally, in spite of the over-activity of the sudorific function, the elevation of the tension of vapor in the atmosphere of the para-equatorial countries is opposed to a complete evaporation of the perspiration. The evaporating power often falls to the minimum; the perspiration collects in small innumerable drops over the body, is retained and flows along the integuments. From that time cooling of the body is defective, and there is direct tendency to hyperthermia. The temperature of the European under the tropics, at the beginning of the sojourn, is more elevated by about ½ degree centigrade. (Davy, Battray, Jousset, Naval Surgeons.)

The author gives the following conclusions:—

(1) Vapor of water has a strong tension and occupies an important part in the total barometic pressure, and the more the over-tension of the dry air is lowered the more the oxygen is diminished, which results in the tropical anæmia.

(2) Pulmonary exhalation and cutaneous evaporizing power is concurrently lower in warm countries; hence hydræmia, plethora, retention of caloric with tendency to morbid hyperthermia.

(3) Augmentation of general pressure which takes place in the European during the first months of his sojourn under the tropics, notably during the winter season, determines venous dilation, congestion of the abdominal viscera, polycholia, and sometimes intestinal fluxes.

(4) Finally, under the influence of the exuded perspiration, two phenomena are produced: (*a*) an increased quantity of chloride of sodium is eliminated by the skin, hydrochloric acid diminishes in the gastric juice, and the latter becomes insufficient; (*b*) on the other hand, under the influence of abuses of ingested liquids, the muscular wall of the stomach is weakened, and becomes distended; these two circumstances combined determine gastro-intestinal dyspepsia.

As a prophylactic for the resident in these hot countries, he recommends that, among other things, "alimentation and dressing must be based upon the necessity of reducing to the required minimum the ration of liquids, and to facilitate evaporation. The occupation of the European in the inter-tropical countries, and particularly equatorial regions, must be regulated in such a manner as not to expose him to the sun between 11 o'clock in the morning and half past 3 in the afternoon; and in no case should he be given the work of cultivation of the soil. The rôle of the European who has emigrated to the warm countries must be to direct, and not to make with his own hands an agricultural demonstration for which he would not have sufficient physiological resistance."

III. Electricity.—Recent literature on this subject is not abundant. There are few separate references to its influence upon health during the period covered by this issue of the ANNUAL, except such as have been mentioned under the topic of *Light.*

The commission appointed by the New York Legislature to investigate the most humane and practical method of carrying into effect sentence of death in capital cases, reported that the present method of inflicting the death penalty (hanging) should be abolished, and, as a substitute, that a current of electricity, of sufficient intensity to destroy life instantaneously, be passed through the body of the convict. Dr. George E. Fell, of Buffalo, made a number of experiments with electricity on dogs in July, 1887, and demonstrated not only that electricity was perhaps the speediest mode of

death known, but that if the current used was sufficiently powerful, attempts at resuscitation in the case of a criminal executed by electricity would fail. Professor Elihu Thompson, of Lynn, Mass., writes the commission that the strength of the current which will produce death depends largely upon the nature of its source, and upon the direction of its passage through the body, and besides, varies greatly with the peculiar individual constitution of the subject. In most cases death seems to be the result of nerve exhaustion and asphyxia. In others it may be due to a rupture of the blood-vessels or injury to the valves of the heart as a consequence of violent contraction under the enormous stimulus of powerful currents. Broken or interrupted currents or alternating currents, the waves of which are abrupt in character, are without doubt the most powerful in injurious effects upon the animal system." The most certain way to produce death "would be to pass the current down the spinal cord from the crown of the head, as by the sudden application of wet surfaces or sponges. The result would be, I think, with a sufficiently strong current of the proper character, a painless extinction of all the faculties."

The well known inventor, Mr. Thomas A. Edison, wrote the Commission that in his opinion "the most suitable apparatus for the purpose is that class of dynamo-electric machinery which employs intermittent currents. The most effective of these are known as alternating machines. The passage of the current from these machines through the human body, even by the slightest contact, produce instantaneous death."

It is to the therapeutists, however, rather than the hygienists and publicists, that the interest in electricity for medical purposes centres. It is well known that the body offers considerable resistance to the passage of the electric current in certain instances, and that there is a great variation in this resistance in different individuals. Charcot demonstrated that the resistance to electric currents was constantly lessened in certain cardiac affections and in Graves' disease. The experiments of Charcot have been repeated and elaborated by Wolfenden.[15] "He tested the resistance in fifty healthy persons, and found it between 4000 and 5000 ohms with a current of 15 volts. In eighteen cases of undoubted Graves' disease he found this resistance to vary between 500 and 1500 ohms. In eight of these it was 1000 or less. This fully

corroborates Charcot's operations. In ordinary goitre the resistance is not lessened, but was found to vary between 5000 and 6000 ohms. In one case of malignant disease of the thyroid it was found to be 8000. In some cases of hemiplegia it varied from 1300 to 4000; in the same number of cases of epilepsy from 1000 to 4000; in three cases of cerebral softening it was 3000; in two cases of paraplegia it averaged 3000; in one case of general paralysis 6500; in one case of infantile paralysis 2600; in a case of hystero-epilepsy 1600 ohms; and in one case of chorea in an adult it was 350. Dr. Wolfenden further noticed that a current of only two or three volts would in Graves' disease produce marked deflection of the galvanometer needle: with such a current no deflection would occur in health. The bodily resistance is therefore almost nothing in this disease. Dr. Wolfenden can offer no explanation of these changes.

The general effect of electric environment has been well studied by Professor Fazio,[16] who, after referring to the general fact that there is no phenomenon in nature which is not preceded or followed by electric manifestations capable of being detected by delicate appliances, states, following Gay Lussac and Biot, that in fair weather the atmosphere is positively electrified, and that the soil and all bodies on it are negatively electrified. Curious experiments are cited by Fazio to discover the relative degree of electric tension at different periods of the day. Those of Prof. Turley, of Worcester, are cited, in which it is stated that the first minimum of electric tension is at sunrise, while the maximum is at 8 o'clock in the morning. The second minimum occurs at 3 or 4 o'clock in the afternoon, and the maximum tension at 8 o'clock. The relative humidity of the air has an important influence on the electric tension, which also varies according to whether the weather is fair or cloudy.

The temperature of the atmosphere has much to do with the direction of electric currents. Thus, in summer electricity is conveyed from the earth to the clouds in ascending currents; in winter it remains concentrated near the earth in the lower strata of the atmosphere.—[Fazio.]

Experiments on sea torpedoes, electric fish, and other animals, seem to show that single electric currents are developed in the organism, in nerves, muscles, and glands, and that the human

organism is also capable of electric discharges under certain circumstances.

Electricity developed in the human organism in a state of health is generally positive. The point of therapeutical value in connection with electrical therapeutics is found in the fact that electricity almost entirely disappears in rheumatism. That there is a certain relation between the state of the atmospheric electricity and the progress of certain epidemics has been known for a considerable period, but little progress has been made in determining it with accuracy; but recent experiments seem to show that bacteria are destroyed in cultures by the passage of currents of electricity through the media. Hence the popular belief in the purification of the air after electrical storms has a scientific basis.

IV. *Air.*—By some experiments by MM. Cadéac and Malet on the transmission of infectious maladies by the expired air in cases of charbon and rot in sheep, the conclusion was reached that the fever of charbon was not transmissible by the expired air, but that water obtained by condensing the vapor of expired air from animals suffering from the rot inoculated into healthy animals did not in a single case transmit the disease. When animals suffering from the rot were placed at a distance of 50 centimetres from animals suffering from acute catarrh of the larynx, they did not contract the disease. Thirty animals which were made to inhale from three to ten hours the air expired by nine diseased ones, remained healthy, even when they were separated at a distance of eighty centimetres. As to the conditions affecting distribution of micro-organisms in the atmosphere, Dr. Percy Frankland[18] cites Hesse's experiments, which show the rapid gravitation of organisms in comparatively still air, and the more rapid gravitation of bacterial organisms than mould organisms. With reference to sea air, experiments showed that the maximum distance to which, under ordinary circumstances, micro-organisms can be transported across the sea, is between 70 and 120 nautical miles. The question of gravitation of germs has a practical importance in the ventilation of houses and public edifices, especially those that are furnace-heated, where too frequently the air from the flues is taken directly from the cellar in which there may be several more or less objectionable sewer connections.[19] Dr. D. F. Lincoln, in a report on School Hygiene, remarks:—

"There is much carelessness about the source of air which is drawn into furnaces for heating, and sent up into rooms. . . . . Bad air, malarial air, is known to settle upon the ground in many cases. The ground-level is less reached by the renovating breezes than higher levels. As a rule, openings for drawing the outer air into the heaters had better be at points above the children's heads, and covered with wire netting."

"It cannot be too often repeated that the purity of cellar air lies at the foundation of the purity of house air."

In a paper read by Dr. Theodore Williams,[21] at a meeting of the Hospital Association, April 23, 1887, he said that his attention having been directed to the varying impurity of hospital atmosphere, the results of his analysis showed that with an insufficient cubic space came first an increase in carbon dioxide, then an increase in organic matter. He gave the following conclusions:—

1. That to maintain the proper standard of purity in a hospital atmosphere in this climate [England], some form of artificial ventilation, combined with warming the air, is necessary.

2. That no system which does not provide for a change of air at least three times an hour, beyond the extraction by fire-places, should be adopted.

3. That if extraction by heat is used, it is of the utmost importance that the temperature of the extracting shaft should be maintained as thoroughly in summer as in winter.

4. That the water-closets and slop-sinks of a hospital should be ventilated separately from the wards and corridors.

A case of death from overcrowding is reported in which the patient was taken sick in the morning and a physician called at noon. He found the atmosphere of the room overpowering. The house contained four small rooms, in which were lodged eleven persons. The room which the patient occupied contained a cubic space of 842 feet. Seven persons slept in the room and the jury found a verdict that the deceased died from asphyxia, caused by overcrowding.

Regarding the influence of air in the causation of disease, Dr. Russell[22] has established by a large body of statistics the fact that house accommodation is much the greatest factor in determining the death rate; that the greater the number of persons living in one room, the more limited the air space, the more impure the air,

the higher the death rate. The conclusions arrived at by Dr. Henderson,[23] from a study of Dr. Russell's pamphlet, is that our common diseases are dependent for their existence upon causes which are material; that this material is present in large quantity in the air of crowded dwellings, and occasions the prevalence of these diseases in such localities. Notwithstanding the experiments of Cadéac and Malet, Dr. Henderson[24] concludes that air germs may "normally traverse the pulmonary membrane, and pass alive into the blood. If they do not, it must be due to one of two causes,—either that these hardy, organized particles are killed by contact with, or in the act of passing through a thin membrane, or that they are too large to permeate its pores. We know that they are exceedingly minute. Dr. Burdon Sanderson proved that when suspended in a fluid (where we may suppose they are somewhat larger than in air from imbibing moisture) they can pass through all kind of filters except one of unglazed porcelain."

Professors Carnelly, Haldane, and Anderson[25] reported at the Royal Society of London some interesting investigations on carbonic acid organic matter, and micro-organisms in air, especially of dwellings and schools. The following deductions were drawn by the authors from the results of numerous and careful experiments:—

"1. As we pass from four-roomed and upward to three, two, or one-roomed houses, not only does the air become more and more impure as indicated by the increase in the carbonic acid and organic matter, but more especially of the micro-organisms, but there is a corresponding and similar increase in the death-rate, together with a marked lowering of the mean age at death.

"2. The rapid increase in the death-rate as we pass from four to one-roomed houses is by far the most marked in children under five; the death-rate among these young children in one-roomed houses is nearly four times as great as in four-roomed houses, whereas the general death-rate is not quite twice as great; further, although there is still a marked increase in the death-rate for all above five years of age in the smaller houses, yet this increase is comparatively small and is not evident unless the deaths in the infirmary and poor houses be included in the one and two-roomed houses."

Dr. A. T. Dobrotvorski has published observations on the

character of the air in the holds of Russian men-of-war. "In the bilges of the *Peter the Great*, the largest vessel in the Russian Navy, the moisture was found to be 89.5 per cent., the CO_2 4.6 per 1000, the free ammonia 0.026 milligramme per 1000 litres, and the albuminoid ammonia 0.246 milligramme. The highest estimate of CO_2 were in frigates and floating batteries, the lowest in clipper ships. In the engine-room of the *Admiral Spiridoff*, an iron frigate built in 1868, the CO_2 was found to be as high as 8.22 parts per 1000. The ammonia found varied a great deal, being, however, only slightly higher in the frigates and batteries than in clipper-built vessels, and bearing little relation to the quantity of CO_2; thus in the bilges of the *Peter the Great* the albuminoid ammonia was 0.246 milligramme per 1000 litres, in the engine-room of the *Admiral Spiridoff* 0.154 milligramme, while in a part of the floating battery *Pervenets*, where the CO_2 was only 2.37 per 1000, the albuminoid ammonia was 0.564 milligramme per 1000 litres."

V. *Soil.*—The study of the soil is chiefly interesting to the hygienist on account of the matters it may contain, and, through evaporation, distribute through the air or by percolation transmit to drinking water. In the study of this subject, Inspector-General John D. MacDonald,[26] Royal Navy, arrives at the conclusion that agricultural blights in general are produced by the distribution of organic matter during evaporation. While rivers carry off a great amount of organic waste, very much of it is distributed through this evaporating process. Porous soil being the holding ground for animal and vegetable débris, ground water should be studied in connection with the ground air. The chemical examination of ground air shows an increase in the relative amount of carbonic acid in proportion to the depth. This was the result of the examination of the ground air at Netey. The effects of turning up ground in malarial localities is shown to invariably increase the number of cases of malarial poisoning in persons exposed to this air. Dr. Richard H. Day,[27] of Baton Rouge, La., in an examination of the facts obtained by addressing letters of inquiry to five hundred physicians residing in localities subject to overflow of the Mississippi River, finds that these overflows are injurious to the public health, and that to promote the health of laborers and residents in the river delta and low lands, the dwel-

lings should not be less than four feet from the ground, the floors laid tight, and doors and windows arranged to afford free ventilation, with galleries on all sides wide enough to prevent beating rains from wetting the rooms. The houses should be erected on ridges so that the water will not settle under or around them. Only a few shade trees should be allowed to grow, to break the force of the direct rays of the sun; and all brush and undergrowth should be removed so as to facilitate the free movements of currents of atmosphere. The writer further shows that under improved methods of rice culture, the management of land subject to overflows, and the frequency and virulence of diseases incident to those localities, have been notably diminished.

However desirable it may be to remove the forests from marshy and swamp lands, it is evident, according to Dr. Eugenio Fazio[28] "that forests have a climatic and sanitary value of the first order," and that "the arithmetical progression of the evil effects which follow the vast and senseless denuding of forests, now so much deplored, will assume grave geometrical proportions if not energetically resisted."

On the subject of characteristics of the soil in hot countries, see also Treille under heading of HEAT.

VI. *Water.*—The hygienist pursues the study of water with two objects in view: *First*, its purity for potable purposes and its action in the production of disease, when contaminated; *second*, its capacity as a culture medium for germ multiplication. The following headings will serve as definitive of the methods required in water analysis: *First*, physical examination; *second*, quantitative examination of dissolved solids in water by chemical analysis; *third*, the biological examination.

The hydrant water of Berlin was recently examined by Wolffhuegel and Riedel.[29] Specimens of the following sorts of water were also examined: water from the lake; hydrant water, and water from various wells. Experiments on this water were divided into those with non-pathogenic and pathogenic organisms. The non-pathogenic germs constantly found in hydrant water in Berlin are, first, a short bacillus with motion, which liquefied the gelatine and produced green fluorescent colonies; second, a short bacillus with motion which did not liquefy the gelatine and produced a fluorescence outside and around the colonies; third, a

short bacillus with motion, forming yellow colonies with liquefaction of the gelatine; fourth, a short bacillus with motion growing on gelatine without liquefying the latter and the superficial colonies, forming a dull mother-of-pearl lustre.

The pathogenic germs tested were the bacilli of anthrax, typhoid fever and cholera. The authors found that typhoid-fever bacilli and anthrax were capable of multiplication in river-water, well-water, and hydrant-water under favorable conditions of temperature, and the anthrax bacilli increased even in unsterilized water, where the competition with the aquatic bacteria was not eliminated. Cholera bacilli, it is true, perished, or nearly perished in unsterilized water in a very few days, but in sterilized drinking water, on the contrary, they showed, first, a diminution and afterward a continuous and abundant increase. Even after seven months there were an abundance of living cholera bacilli in the test tube. In distilled water they found a rapid death of cholera bacilli.

Dr. Theobald Smith[30] in a study of the quantitative variations in the germ life of Potomac water, in January, 1886, gives the following table of monthly average of the bacteria found in one c. c. of Potomac water:—

1886.	Number of Observations.	Average.	Rain Fall. (Inches.)
January	2	3774	3.46
February	4	2536	2.79
March	5	1210	4.16
April	4	1521	4.21
May	3	1069	7.77
June	2	348	4.98
July	2	255	8.42
August	1	254	1.03
September	2	178	1.04
October	3	75	2.31
November	1	116	3.69
December	2	967	3.07
1887.			
January	3	882	2.19

He explains the increase of bacteria during the winter months by the fact that the heavy rainfall in the winter washes down the soil from the surface drained by the tributaries of the river, and although the rainfall is heavier in summer than in winter, as shown by the observations of the Signal Office, yet the presence of luxuriant vegetation at that season prevents its being washed into the river.

In a chemical and biological examination of the water of New York Bay, Ass't-Surgeon J. J. Kinyoun,[31] of the Marine Hospital Service, reports that sea-water in this bay is so contaminated by sewage that micro-organisms grew and developed therein, and the Finkler germ was still viable in this water up to the date of the report,—a period of sixty-nine days.

During the year the capacity of river-water as a medium for the propagation and cultivation of pathogenic germs has been illustrated in the Ohio Valley. At many towns on the Ohio River, extending from Bellaire, nearly to the mouth of the Ohio River, a distance by river of over eight hundred miles, nearly every town obtaining its water supply from the river was more or less infected by typhoid fever. Doctors Rushford and Cameron,[32] of the Bacteriological Laboratory of the Medical College of Ohio, succeeded by Brouardel's method in demonstrating before the Cincinnati Academy of Medicine the bacilli of typhoid fever in the water of the Ohio River, and the epidemic of typhoid fever was therefore attributed to this source.

M. Hueppe,[33] of Wiesbaden, in the Vienna Congress of Hygiene, in a comparison of the mortality of typhoid fever and cholera in the cities which derive their drinking water from conduits, arrived at the conclusion that in ordinary drinking water the conditions are not favorable to the propagation of the germs of the disease; but sometimes, under certain conditions, the germs are preserved for a very long time. To prevent contamination he recommends some of the following measures:—

(*a*) To preserve wells and fountains from contact with the waste-water pipes proceeding from household drains, and to construct reservoirs with impermeable walls, and place the wells and fountains as far as possible from privies; (*b*) to supply the absence of wells and fountains by water brought by canals; (*c*) to purify the sources of the canal by natural filtration of the waters, by perforation (boring); (*d*) to filter through sand all other water, by small irrigation ducts, and then collect the filtrated water; (*e*) to avoid the accumulation of stagnant water by continued and rapid action of hydraulic machinery. In the discussion which took place on this paper, M. Roehl, of St. Petersburg, related a series of experiments which proved that the vitality of the bacteria in water depended on the chemical property of that water.

MM. Brouardel, of Paris, Durant, of Geneva, Lehmann, of Copenhagen, Kowalski, of Vienna, Petresco, of Bucharest, and Biesadecki, of Lemburg, each related cases of typhoid fever produced by the infection of drinking water.

It may therefore be fairly concluded from the examination of the immense amount of literature of the year on this subject, that the question of the viability of germs of typhoid-fever in drinking water is set at rest. Under the heading of *Epidemiology*, the question of the propagation of this disease will be further adverted to. It is fully established beyond a doubt by biological experiments upon the propagation and development of bacteria, that their growth and propagation in water depend on the organic matter therein present. The necessity, not only of preserving the sources of the water supply from contamination, but its thorough filtration afterward, has become apparent. Filtration of water, while not excluding all microbes, serves completely to exclude the solid matters suspended in the water and much of the organic material. A complete review of the voluminous literature of this portion of the subject is not possible in the limits assigned to this article.

ALIMENTATION.

1. *Food Supply.*—The literature of the physiology of food is not included within the scope of the subject assigned to the writer, and he will therefore consider the adulterations only.

MM. Vallin, Lécuyer and Duprés,[34] of Beaurieux, have written two memoirs cautioning against the use of milk from cows suffering from pleuro-pneumonia. The first observations cited by the authors are those of Dr. Costello, a physician attached to the British Army in India.

In March, 1875, there was a severe epidemic of pleuro-pneumonia, which infected both lungs. The disease passed rapidly to red hepatization and the formation of abscesses, sometimes gangrene, and at the same time an effusion of sero-sanguinolent fluid into the pleural cavity. Of 550 men exposed, 40 died in a few weeks, and from another regiment which relieved the first, there were 60 men lost. Dr. Costello believed that this contagion was transmitted by the food, but after a careful study of the cases M. Vallin arrived at the conclusion that it was entirely due to the milk served from sick animals. (2) In 1859 Mr. Philippe Heu observed that

two calves which were fed with milk of cows suffering from pleuro-pneumonia, contracted the disease and died therefrom, as proved by the autopsy. (3) Mr. Elvire, a distinguished veterinary surgeon from La Capelle, observed in Rocquigny, at the house of a farmer, the head of a numerous family, who possessed a herd of milk cows, that four cows were affected with pleuro-pneumonia, and that from these diseased animals, five children and the mother consumed large quantities of the milk without boiling. They were soon attacked with general malaise, characterized by prostration, loss of appetite, headache, congestion of the face and weeping eyes. They were cured, however, in about a fortnight. The father and the elder son did not use the diseased milk, and were neither of them sick. The authors observed, at the same time, cases of pneumonia, of an infectious form, in two children who were exclusively fed on milk from pleuro-pneumonic cows. A third infant of the same family, who always refused to drink it, was not affected. While the authors do not claim that these cases confirm their hypothesis, it still bears it out sufficiently to require that milk should be boiled where it is suspicious.

Mr. W. H. Power,[35] in a report to the Government of the Local Board, on an outbreak of diphtheria in Yorktown and Camberly, that became suddenly epidemic in October, said: "Of 176 households, within the area selected for investigation, 57 were infected in that month, the attacks of diphtheria being 88; those of less grave throat illness 47; those set down as scarlet fever 5; and the deaths were 16 in number. Of 140 persons affected, 90 per cent. were attacked in the eleven days between Oct. 8 and 18, inclusive." The report, after investigation, set aside such conditions as local drainage and sewerage arrangements, water, and emanations resulting from deposits of river mud,—all of which were originally suspected. 84.2 of the cases had derived their milk supply from the particular dairy under suspicion. 48 houses were invaded in the period named. As regards the persons attacked, of 140 individuals suffering from more or less grave throat illness during Oct., 124 of them, 88.5 per cent., were members of families using the same milk, and it was further distinctly shown that the extent of the diphtheria had to do with the quantity of the milk consumed.

Dr. Julius S. Clark[36] in speaking of the propagation of diph-

theria, which prevailed epidemically in Melrose and Malden during June, July, and August, 1886, states that it was the direct and immediate outcome of an infected milk supply; that out of 16 foci of infection, 13 had received the infected milk. Dr. E. Klein,[37] of London, in an address before the Royal Institution regarding scarlet fever, finds that a microbe scarlatinæ is the cause of human scarlet fever, and that it produces in bovine animals a disease identical with the "Hendon" disease and human scarlet fever; and that, consequently, while the cow is subject to infection with human scarlet fever, it can in its turn be the source of contagion for the human species. The conclusions reached by Dr. Klein are: (1) in the blood and tissues of persons infected with scarlet fever, there occurs the same micrococcus that was present in the cow; (2) that calves and mice, after inoculation or feeding with a trace of the growth of both sets of micrococci, become infected with cutaneous and visceral disease similar to human scarlet fever; (3) from blood and tissues of these animals infected with one or the other set of cultivations, the same micrococcus was recovered. Dr. Klein also found the micrococcus of scarlatina in several cans of cheap condensed milk, which, in his opinion, was not raised, in the manufacture, to a temperature high enough to destroy the micrococcus. Dr. Klein believes that the milk of scarlatinous cows may convey the infection in two ways, both as a secretion of a diseased animal, and from the mingling in it of contagious particles brought off from the udder by the hands of the milker. He finds that a temperature of 85° C. will destroy the micrococcus of scarlatina; hence, recommends that the milk be heated to that point, though not necessarily boiled.

Dr. Victor C. Vaughan,[38] who has been for some years studying the chemistry of tyrotoxicon, a poisonous ptomaine found in cheese and milk, has announced that tyrotoxicon and diazo-benzole are one and the same thing, and numerous instances are reported of poisoning in food of various kinds from tyrotoxicon. It would be impossible for one not specially looking for it to imagine the vast space occupied in medical literature by the record of isolated cases of poisoning by reason of these adulterations. It seems that scarcely any article of food supply is exempt. Dr. Marshall,[39] of the University of Pennsylvania, reported that lead chromate (chrome yellow) was systematically used for coloring

cake by the bakers of Philadelphia. This adulteration was also practiced in France, according to Dr. Galippe,[39] a practitioner in the Département de l'Oise. It originated on account of the scarcity of eggs, the yellow chromate of lead being used to give the yellow tint to the pastry. Dr. Galippe discovered 73 milligrams of oxide of lead in each 100 grams of the product.

In Paris, it is reported that notwithstanding the watchfulness of the sanitary authorities, out of 645 samples of wine examined in November, 1886, 450 were injurious; out of 88 samples of beer, 5 were bad; of 18 samples of spirits only 1 was condemned. More than half the samples of water examined were reported to be dangerous, and 80 out of 370 specimens of milk were dangerous. Out of 81 loaves of bread, 30 were worthless. The coffee was very little adulterated; the butter was fairly satisfactory.[40] Dr. Rjaeltschevski,[41] of St. Petersburg, has proved that the percentage of lead in ordinary solder used for tin cans, varies from 59 to 69 per cent., and that in this state it is quite soluble in the fluid of fruits. English chemists, however, have not corroborated this statement. Prof. Attfield stated to the Pharmaceutical Society that "the public has not the very faintest cause for alarm respecting the occurrence of tin, lead, or other metal in canned goods." Dr. Thos. Stevenson,[42] Government Toxicological Analyst, London, in an article on "Poisoning by Canned Foods," read before the Medico-Legal Society of New York, said: "Acute metallic poisoning by canned provisions is not known to have certainly occurred in this country. I have been Government Toxicological Analyst for thirteen years, and have never met with acute metallic poisoning by canned foods." Dr. North,[43] in an exhaustive article on this subject, finds that "the symptoms of canned food poisoning differ materially from the toxic effects of metallic salts."

A committee of the Académie de Médicine, of Paris, of which M. Vallin was secretary, made a report[44] that salicylic acid was added to much of the beer sold in Paris merely as a preservative. The committee concluded that, "it being well established by medical observation that small and prolonged daily doses of salicylic acid and its derivatives can cause considerable trouble to the health of certain persons who are sensitive to those drugs, particularly old people and those whose renal or digestive organs are no longer in

perfect order, therefore the addition of the salicylates to liquid and solid aliments should not be permitted."

The report of the committee was opposed by M. Constantin Paul, but the conclusions were adopted with only two dissenting votes, those of MM. Féréol and Constantin Paul.

In Germany, wine has been found adulterated with the following substances and the sale of such wine prohibited as dangerous to health: compounds of barium and lead, glycerine, cochineal, compounds of magnesia, salicylic acid, impure alcohol, glucose and aniline.[45]

The following adulterations of some of the simpler foods are noted by Mr. John E. Gemmell:[46] *Milk.*—Adulterated with water, starch, and gum turmeric; emulsions of seeds, such as hemp and almonds; chalk and carbonate of soda. Cream has been adulterated or even manufactured with carbonate of magnesia, tragacanth, and arrow root, and under the microscope this arrow root has been found mixed with carbonate of magnesia. Cheese is adulterated with various coloring vegetable matters and starch, arsenical washes, lead pastes, and sulphate of copper, and during decay the following organisms have been noted: the *acarus domesticus*, *aspergillus glaucus*, and *sporendomena casei*. [And, as Professor Vaughan has shown, the chemical poison tyrotoxicon.—Ed.] The ptomaines of meat, according to Wolfenden, are met with (1) as constituents of normal tissues or juices, being products of tissue metamorphosis; (2) in some pathological conditions from the urine, (*a*) in progressive paralysis an alkaloid like nicotin and one like conine, (*b*) pneumonia, (*c*) typhus, and (*d*) tetanus and finally a cadaveric or artificial production. *Bread.*—Among the adulterations are rice, flour, potatoes, bean-flour, pea-flour and various fungi; such inorganic adulterations as alum, borax, sulphate of zinc, carbonate of lime, carbonate of magnesia and ergot. *Tea* is adulterated by adding other leaves than those of the tea plant, facing-sand strongly impregnated with iron, and catechu. The leaves most commonly used are willow, sloe, valonia, oak, plane, beech, elm, poplar, hawthorn, and chestnut. The "facing" is done with green teas, the substances used being indigo, Prussian blue, clay, carbonate and acetate of copper, curcuma, gypsum and chalk. If the leaves and the scrapings be examined, blue particles of indigo and Prussian blue are at once detected. *Coffee.*—The usual adulterations

are chicory, roasted wheat, beans, rye, and potato-flours, acorns and burnt sugar." The Massachusetts Board of Health[47] found in addition to the adulterations above mentioned the following in the foods named: *Spices.*—Addition of starch and other foreign powders. Especially true of pepper and mustard.

Among the adulterations of pepper, "spent ginger has been found, and also for adulterating ordinary ginger. The diminished pungency is counteracted by soaking the ginger in an infusion of cayenne pepper. The ginger is then put through a drying process, and afterward ground, but as there are no visible particles of capsicum, the adulteration cannot be detected by the eye. This ginger so prepared is stated to go entirely into the hands of those aërated-water makers who have to meet the demand for a very cheap article" (of ginger ale).[48] *Cream of Tartar.*—Substitution of starch, gypsum, and other cheaper substances. *Baking Powders.*—Alum and other injurious ingredients. *Olive Oil.*—Substitution of cheaper oils. *Lard.*—Cheap fats and oils. [In an examination before the Committee of Agriculture of the U. S. Senate it was shown by the testimony of several large manufacturers of the United States that cotton-seed oil and stearine were largely used in the manufacture of so-called refined lard. It was not shown that the cotton-seed oil was in any way harmful in its effects.—[Ed.] *Jellies and Preserved Fruits.*—The substitution of cheaper fruits, and additional coloring matter. *Vinegar.*—Absence of the required amount of acetic acid and addition of coloring matter.[4] [Crude acetic acid for the manufacture of vinegar is now obtained in large quantities by the conversion of pyroligneous acid, heretofore a waste product of the wood creosote factories.—[Ed.] *Honey.*—The substitution of cane sugar, glucose and other substances. *Molasses.*—The addition of glucose, the presence of tin, or other foreign substances. *Sugar.*—Glucose and poisonous coloring matter. *Maple Sugar and Syrup.*—Glucose. *Confectionery.*—Terra alba, poisonous coloring matter, fusil oil, arsenical wrappers." *Olive Oil* is extensively adulterated with cotton-seed oil, and in many cases cotton-seed oil is sold as olive oil.[49]

MM. Arloing et Cazeneuve[50] in an article on the physiological effects of coloring matter employed in the coloration of foods, made a special study of the physiological action of the color-

ing matters most used; on dogs, pigs and men, both healthy and sick, and present the following conclusions: The yellow of binitronaphtol is poisonous, and resembles the other nitrogen derivatives, such as picric acid, but the sulphur compounds with nitrogen seem inoffensive. Safranine and methylene blue are dangerous. They produce violent gastro-intestinal disorders. They found that the following coloring matters were tolerated both in health and disease: purple, orchell red, Bordeaux red, poppy color, orange, solid yellow, sulphur combined with fuchsine.

In Australia, two children were treated at the Melbourne Hospital with symptoms of poisoning. Investigation showed their illness to arise through eating some biscuit the coloring matter of which was found by the Government analyst to be arseniate of copper. A search through the city resulted in the confiscation of eighty cans of biscuits, having green coloring matter on them, which were confiscated by the Board of Health.[51] MM. Poincaré and Vallois[52] have examined the question of the artificial perfumes used in flavoring extracts, and find that while in large doses these substances injected under the skin are poisonous to animals, yet in the infinitesimal doses in which they are used in artificial flavoring they are practically innocuous. These perfumes are such bodies as amylic valerianate, amylic butyrate, butyrate ether, propylic ether, and caprylic alcohol. The odor and flavor of the apple, the pear, the pineapple, the strawberry, and the raspberry can thus be imitated by these perfumes.

Dr. Donald Campbell,[53] of Calne, recently reported the fact that lead poisoning in and about Calne was being largely brought about by the use of home-made wines, which, during the process of fermentation took up the lead contained in the glaze with which the local earthenware pans were coated. Mr. J. S. Cowley found the same result in a home-made plum wine in the Upton-on-Severn rural district. M. Peligot[54] has discovered that foreign manufactured bottles imported into France are in many cases adulterated during the manufacture. Ferruginous materials are constantly employed in the manufacture of glass for the bottles, and upon these constituents the acids in the wine act with vigor, and the wine thus becomes spoiled.

Red Cod.—For a long time it has been known that the red cod (*morue rouge*) were unhealthy fishes, and their ingestion likely

to be followed by choleraic symptoms of grave character, which, although severe, were not accompanied by any very great mortality. On the 31st of December, 1885, the French Ministry prohibited their use. As an important industry of the French territories on the Mediterranean was seriously affected by this order, experiments have been undertaken with a view of determining the cause of this coloration of the cod. It is found that it is a parasitic malady, caused by certain micro-organisms, and that this coloration progresses rapidly with putrefaction. M. Heckel[55] has found that with a 5 per cent. solution of sulpho-benzoate of soda he was able to prevent the progress of the disease, and by an 18 per cent. solution not only did the fishes lose their red quality, but they acquired a beautiful, healthy color, and a peculiar lustre. M. Heckel therefore believes that he has found a remedy for the red cod by the placing of the fish in a solution of the sulpho-benzoate of soda for twenty-four hours.

The addition of various preservatives to articles of food, such as milk and butter is becoming more common. In some countries "salicylage" is still practiced on an enormous scale, many samples of Brittany butter actually glistening with crystals, possibly mistaken by the purchaser for salt.[56]

Lead Poisoning from Flour.—"A very remarkable epidemic of lead poisoning has recently been investigated in three communes in the north of France. Upwards of 100 persons were suddenly attacked with violent symptoms, among which severe colic predominated. So serious did the condition of some of the sufferers become, that medical aid was obtained, and the presence in several patients of a characteristic blue line on the gums gave rise to the suspicion of lead poisoning. The water supply was derived from so many different sources that it could not be incriminated, and suspicion ultimately fell upon the flour. It was ascertained on inquiry that the affected persons had all obtained their flour from the same mill, but those who had partaken of rye bread were most severely attacked. The mill was gone over and after a long and painstaking examination, attention was directed to the tin buckets of the elevator which served to transport the rye flour from the grind-stones. Several of these buckets had a dull, leaden appearance, and were found to have been 'tinned' with lead. As doubts were entertained whether the quantity of lead from this source were

sufficient to give rise to such severe symptoms, they were carefully weighed, and were found to have lost upward of 150 grammes of their weight. The wheaten flour, which passed through another elevator, was free from lead, and this was evidently due to none of these 'leaded' buckets having been employed in its construction. The accuracy of the discovery was confirmed by the observation that those who ate rye bread exclusively were most severely attacked, while the others, who mixed the two flours, escaped with comparatively slight symptoms."[57]

The above cases were investigated by MM. Bertrand and Ogier,[58] who came to the conclusion "that leaden vessels employed in transferring meal may be a cause of serious lead poisoning, and that the lead enters the system in the form of sulphide. The sulphur must have been derived from the fissures in the grindstones which had been obliterated by the use of sulphur."

D. Flüger,[60] of Chemnitz, records several cases of poisoning by meat, additional to 77 previously published cases, attacked on June 1 and 2, 1885. These were members of 36 families who had eaten for dinner, either on May 31 or June 1, meat either boiled or slightly fried. The attacks began the day following, and were characterized by sudden, severe sickness, general lassitude and a sensation of cold, sometimes a chill. These symptoms were followed by heaviness of head, or headache, loss of appetite, increased thirst, nausea, vomiting, colic and more or less severe diarrhœa, continuing for several days. The patients were confined to bed, were restless and slept but little. Some of the younger patients manifested symptoms of syncope. Duration of the attack was from 3 to 5 days, relief being afforded by cessation of diarrhœa, with profuse sweating. Recovery was gradual. On May 2, 1886, a great number of persons in Chemnitz were similarly attacked, and also after eating chopped beef. In most of the cases, the whole number of which was 111, the meat was eaten raw, and had presented nothing unusual as to color, smell and taste, all calling it healthy and palatable. The severity of the symptoms was proportionate to the amount consumed. It also appeared as if children possessed less power of resistance than adults, the only fatal case being a child of one year old, who had taken but a thimbleful of meat. The post-mortem appearances were similar to those of a beginning abdominal typhus. The meat

examined was of healthy appearance, fresh odor and only somewhat pale because it had been on ice. The sausage showed the same characteristics. Experiments by feeding dogs, rabbits and mice upon the meat had negative results. No bacteria were found, and inoculation and feeding by micro-organisms raised upon meat pepton-gelatin had also no effect. In one of the samples the muscle nuclei were somewhat increased in number, and the interstitial tissue showed numerous round cells. Neither meat nor sausages contained metallic poisons or aniline, nor could ptomaines be demonstrated.

The author inclines to the opinion that the meat was obtained from an animal killed outside of the city, and which escaped examination at the abattoir.

Prof. Johns is of the opinion that the meat, by the process of chopping, was put in a condition favoring development of bacteria and ptomaines; that the high temperature of that season aided in producing the diseased changes. The thermometer ranged from May 16 to May 24 from 18.70° C. to 28.9° C. An acceptance of this theory would lead us to suppose that cases like the foregoing would be much more frequent than they are, because both factors are of common occurrence; hence the author suggests a third factor,—a pathological change of as yet unknown character in the living animal. Just as in man during the period of incubation of infectious diseases, the infectious agent surely leads to changes in the juices, the nature of which is unknown, we may in an analogous manner assume such to be the case in animals. The animal thus infected does not present anything pathological upon examination, and its meat after slaughtering need not show visible changes; and yet the ingestion of such altered meat, especially in the raw state, may have a poisonous effect upon man. In accordance with the present methods of etiological investigation, attention should be directed to the diarrhœal discharges and vomited material, to the contents of the alimentary canal, to the examination of Peyer's glands, the mesenteric glands, liver, spleen and kidneys.

International Control.—At the Vienna Congress of Hygiene, September 26, 1887, the Congress, after discussion of the international measures to be taken against the adulteration of alimentary food and drink, finally decided to appoint a committee on the subject composed of MM. Brouardel and Pouchet, of Paris, and

Hilger, of Erlangen. The committee[59] considered: (*a*) the institution of regular control of alimentary commodities; (*b*) the creation of analytical laboratories, organized on a uniform basis; (*c*) the unification of the methods and procedures of investigations of the alimentary substances; (*d*) international legislation providing for an inspection of alimentary commodities and their disposal for all countries, and the means of execution of the same.

2. The commerce in alimentary commodities should be governed by uniform laws for the different countries; and

3. These laws should be not only of a repressive nature, but also preventive, and, therefore, the creation of laboratories for analysis of alimentary commodities is indispensable.

HABITATIONS.

The subject of ventilation has been touched upon under the topic of air and heat. It is therefore only necessary to refer to those of drainage, and the habits of the inmates of the household as affected by the habitation itself. It has generally been assumed that plumbers, by reason of the frequency with which they inhale sewer air, have acquired a sort of immunity from its poisonous effect; but a recent inquest, in Liverpool,[61] on the body of a plumber, who had been engaged the previous week in repairing pipes connected with a sewer, through which a considerable quantity of foul sewer air escaped, tends to demonstrate the contrary. The man died within forty hours, and the jury returned a verdict to the effect that death was due to the inhalation of sewer air, according to the evidence of the medical witness at the inquest.

Analysis of Paris sewer air shows its composition to be carburetted hydrogen, 72.88; sulphuretted hydrogen, 6.70; carbonic acid gas, 12.30; carbonic oxide, 2.54; miscellaneous gases, 5.68 a thousand. Micro-organisms were also persent.

Intermittent Ventilation.—"A new proposal has just been brought forward for the ventilation of sewers. Mr. R. S. Ash has patented a system of ventilation by the force of concussions resulting from explosions automatically produced. In the man-hole of a sewer, or in the ventilating-shaft of a coal mine, he places a small cylinder where coal gas accumulates until it reaches a little hole, and there comes in contact with a jet burning outside. An explosion results, the lid of the cylinder is blown off, but counter-

weights make it fall back into its place, so that all is ready again for the next explosion. The air is blown out of the man-hole, and a partial vacuum created and filled by the air rushing up from the sewer."[62] It is believed by the *Lancet* that the continued shocks produced by these comparatively minute explosions, will aspirate the air from branch pipes and small sewers more effectually than by the method of blowers or aspirating fans.

Utilization of Sewage.—Mr. Kingzett,[63] of England, has patented an invention for the precipitation and utilization of sewage. The invention consists in mixing powdered coke with clay, and then adding the mixture to the sewage. It is said that the deposit can readily be pressed and that this sewage cake has a certain value as a manure. It is further said that the cake can be air dried and used as a fuel, or it may be carbonized by heat and again used as a precipitant.

Mr. Joseph Jessop,[64] of Pembury, near Tunbridge, has obtained good results with pressed sewage sludge, from Crossness. Mr. Jessop selected sandy soil on rock, and treated portions of it with sewage cake, farm-yard manure, and artificial manures, respectively. He found that good crops were obtained with the sludge. It is believed that this pressed sewage sludge is rather weak as a manure, and cannot, as a rule, stand much cost of carriage.

The extension of the Berlin system is indicated by reports in many of the medical journals. This system is, in brief, the pumping of the sewage into tanks, and the expelling from that by compressed air, driving the sewage into settling tanks at a higher level. Then the drainage sewage from these tanks is distributed over and irrigates land prepared for that purpose, by means, usually, of irrigating ditches. This system is one of great value, not only in preventing the pollution of water in the adjacent streams and rivers, but for the preservation of the sewage. In Berlin a certain revenue is derived from the rental of these irrigation fields, although the system can scarcely be expected to be self-supporting. Among other places in which this system has lately been applied are Henley, England, and Pullman, in Illinois. The system is varied a little at the latter place by the adoption of the separate system, that is to say, the surface drainage is carried away by one system of drains, and the house sewage by another. The surface drainage is not allowed to mingle with the sewage, nor does it go on to the

sewage farm. Luton, England, has lately expended £20,000 in enlarging the sewage farm at that place, and it was stated at a meeting of the municipal authorities in Luton, on October 29th, that the cost of the working was very low, and that the general result was in every way satisfactory. The whole of the sewage of Luton, with a population of 30,000 people, is efficiently disposed of on 20 acres of land.[65]

Disposal of Garbage.—One of the problems of household sanitation is the disposal of garbage, which in some communities is utilized by feeding to swine. In America it is collected by garbage collectors, acting under authority of the city health officer, but the weight of public opinion at present seems to be settled in favor of the disposal of the garbage by cremation. In Milwaukee, Wisconsin, a company has made a proposal to the city council to erect two cremators at an expense of ten thousand dollars, for this purpose. The company claim that the running expenses will not exceed $15.50 a day.[66]

The editor of this section, in his own household, has for the past few years required his cook to cremate the garbage in the kitchen range, thus entirely dispensing with the service of the garbage collector, and while the fire is still hot after the cooking of any ordinary meal, the garbage may easily be cremated without expense or trouble. All solid débris of the kitchen may thus be easily disposed of by each householder for himself where ordinary coal is used for fuel. Household hygiene of country-houses seems to be extremely unsatisfactory in all countries, owing to the fact that the bed-rooms are illy ventilated, the floors are most frequently damp and uneven, and well calculated to cause an accumulation of filth, thus affording a nidus for the propagation of diseased germs; and the cellars give off various unhealthy emanations. It is satisfactory to know that, under the English laws, action for damages against landlords for letting houses in unwholesome conditions are becoming more frequent.[67]

Disinfection of Dwellings.—As to the disinfection of dwellings and their contents, Guttmann and Merke,[68] in the German Society for Hygiene, reported that in their experiments with a solution of corrosive sublimate, one per cent. in spray, the colored materials in carpets, hangings, and walls were not injured, and that of 200 carpets disinfected, none were injured. 27 days after

the disinfection sublimate was found upon the walls, and it could easily be removed by using one per cent. solution of sodium carbonate, which formed an insoluble mercuric oxi-chloride, which, in its turn, was easily removed by sponging. Material saturated with cultures of anthrax, and placed among the materials to be disinfected, showed on examination a destruction of one-half the germs.

The same observers also made an investigation as to the relative value of various methods of disinfecting inhabited rooms.[69]

The main points kept in view in the inquiry were that a satisfactory method should destroy the vitality of the bacteria, and at the same time should not injure the house nor furniture, nor be dangerous to the health of the persons in the house or of the person applying the solution. It should involve the least possible labor in its use, and be as cheap as possible. The bacillus anthrax was taken as the test organism, and was dried on silk fibres and scattered through the room on rugs, etc. Disinfection was attempted by scrubbing the floors, ceilings, and walls with disinfecting fluids, and by spraying the same on the rugs, etc. The disinfectants experimented with were a five per cent. solution of carbolic acid, and solutions of bichloride of mercury of various strengths. Their conclusion is that a solution of bichloride of mercury, 1 to 1000, used as a wash and a spray, is the most certain, the cheapest, and in all respeces the best for disinfecting inhabited rooms.

Deaths from overcrowding are not very frequent, but some cases have been reported during the year. In Wigan, England, a coroner's inquest found a case of death from this cause.[70]

School Hygiene.—The literature of the year has been extremely full in regard to the welfare of the children in public schools. The State Board of Health of New York in its Annual Report, recommends that the following requirements be embodied in the law as essential to the sanitary welfare of the school-children of the State of New York:—

"(*a*) Building should rest on a good dry foundation, and be constructed to insure the comfort of children during inclement weather. (*b*) Class-rooms should be arranged so as to admit light from left side and back of pupils, and the area of windows should be one-fourth of floor-space. (*c*) Not less than 250 cubic feet of

air space should be allowed per pupil, and provision for changing air should be made, so as to secure each pupil not less than thirty cubic feet of fresh air per minute. (*d*) The temperature of the school-rooms should in winter be maintained at a range not to exceed from sixty-eight to seventy degrees Fahrenheit. (*e*) Closets should be provided for each sex, entirely separate from each other and having entirely separate means of access. When situated outside the building they should be about fifty feet distant, and should be connected with it by a covered walk. Privy-vaults should be utterly abolished. Movable boxes or buckets should be placed under the seats, and earth or ashes provided as a deodorant. Buckets should be cleaned out at least once a week. (*f*) In addition to his other legal powers over schools, the Superintendent of Public Instruction should have authority to oblige school trustees to make improvements or repairs in school buildings for sanitary purposes, whenever the local board of health considers such necessary, and their judgment is supported by that of the State Board of Health."

The Academy of Medicine of Paris at its sitting, August 8, 1887, adopted the following conclusions:—

"The Academy of Medicine calls the attention of the public authorities to the necessity of modifying, in conformity with the laws of hygiene and the necessities of the physical development of children and young people, the present arrangements of our scholastic establishments. It thinks that the colleges and lycées for boarders should be removed to the country; that wide, open spaces should be set apart for games; and that the class-rooms should be improved as regards lighting and ventilation." Without dealing with the course of study,—which it desires to see simplified,—the Academy calls special attention to the following points: increase of the time for sleep as regards young children; for all pupils a diminution of the time devoted to study and classes,—that is to say, to sedentary occupations, and a proportional increase of the time for amusement and exercise; the absolute necessity of submitting all the pupils to daily exercise in physical training proportioned to their age,—namely, walking, running, jumping, formations, evolutions, regulated and prescribed movements, gymnastics with apparatus, fencing of every kind, games of strength, etc."[71]

EPIDEMIOLOGY.

Old Books.—Attention has lately been called to the possibility of the dissemination of infectious diseases by means of circulating libraries. Dr. Simson[72] recognized in the house of a patient suffering from scarlatina, a book which he recollected having noticed in the room when on attendance on a previous patient a few days before, who was also suffering from that disease. On inquiry he learned that in the second case the symptoms had commenced within two days from the loan of the book, and while it is extremely doubtful whether this case was communicated through the book named, it is undoubtedly true that the roughened, soft paper may be the means of transmitting the disease.

The *Lancet* believes that the only possible safeguards are to be found, first, in a compulsory notification of infectious diseases to the librarian, so that he may know whether any given householder has had infectious disease in his family during the period in which the book was loaned, and the subjection of every returned book to a process of fumigation before again being loaned. In Sebastopol, Russia, owing to the extreme prevalence of typhoid fever, the librarian of the city library appealed earnestly to the subscribers to cease changing books in case of the fever appearing in their respective families.

Cholera.—India being the home and source of origin of Asiatic cholera, and Calcutta being the most common place of distribution, it merits special attention at the hands of the epidemiologist. The following account of the sanitary condition of Calcutta is very instructive:—[73]

"Calcutta is known to be a breeding place for cholera. The shape of the city is a parallelogram, bounded on the north and south by canals, on the west by a river, low marshlands on the east called salt-water lakes. The interior so called "City" has its own municipal administration; the northern, southern and eastern suburbs have also their own. A society was formed in 1864 to cultivate the marshlands in the eastern part of the city. Till then canals emptied partly in the Hooghly River, partly in the salt-water lakes which are in connection with the Ganges delta, and most fish in the market of Calcutta come out of these lakes. The city engineer proposed to the administration to have the lakes

filled up with sweepings, waste and fæcal matter; 18 acres have been made arable in 20 years at a cost of one million pounds sterling, and it will take 1000 years to fill up all the salt lakes. Unfortunately the fæcal matter returned to its point of outlet, and here the fishing-boats remain over night, whilst the market is held in the adjoining country. The fat of decayed horses, cattle, dogs, and cats is converted into suet and mixed with nut-oil, and used for nourishment by many natives. 14,104 loads of offal were transported by city railway, 1,499 loads of which were used to fill up marshlands near a thickly populated district. The mortality reports show 163,774 deaths out of a population of 251,439, from January, 1873, to March 31st, 1886. There has been a decrease of cholera in the city, but an increase in the suburbs. All bodies are buried outside of the city. Formerly Calcutta was severely afflicted with cholera in the hot months and there were but few cases in the cold season; now the reverse is the case. It is said that there is a plan in view to unite the suburbs and the city and to spend two millions more to "perfect" this curious system of canalization."

Cholera has lingered in certain districts of Italy, and in Palermo during the year, and has also prevailed to some extent in Corea, Japan, and the Sandwich Islands. In the western world cholera has continued to prevail in South America.

It will be remembered that on Oct. 12, 1886, cholera was brought to the Rio de la Platte by the Italian emigrant vessel *Perseo.* This vessel, while authorized to carry about 1000 passengers, actually carried 2017. On the 20th of October cases were reported at different ports of Buenos Ayres.

On November 6th, 12 suspicious cases were reported at Rosario, a city of 50,000 inhabitants, some 200 miles up the Parana river, and by the end of the month of December nearly every town in the Argentine Republic had more or less cases of cholera within its limits. The United States consul at Buenos Ayres, in his dispatch dated January 7, 1887, states that "cholera still exists in this city, but that it makes but little progress in assuming an epidemic form. The average number of cases per day since my last dispatch (December 6) has not exceeded 22. The greatest number of reported cases in one day occurred on the 30th ultimo, when the number reached 57, since which time it has steadily declined, and on

yesterday the number was only 11 in the city, with its population of 400,000 souls."

He enclosed a clipping from the Buenos Ayres *Standard*, from which it is learned that during the months of November and December there were 871 cases of cholera, and 474 deaths from that disease. The consul also states that "the disease has scarcely made its appearance except in closely packed tenement houses (conventillos) of the lower classes and in the suburbs, which are without pipe and hydrant water. In the interior of the Argentine Republic, however, the disease has assumed the proportions of an epidemic. In Rosario, during the last month, the daily number of cases averaged 60 to 100, while about 70 per cent. were fatal. In Mendoza the development of the disease has been most remarkable, and the population of that city of 20,000 has been almost decimated; and in the country districts the disease was equally fatal. In Tucuman the number of cases has on some days been as high as 500, of which about one-half proved fatal. Indeed, the panic at one time was so great that it was not possible to obtain the requisite assistance to bury the dead. In nearly all the other interior cities the disease has been very virulent and fatal; but, not confining itself to centres of population, it has ravaged entire provinces, and farmers (estancierros) and camp men have in great numbers succumbed to it. I am happy to say that with medical assistance, disinfectants, medicines, and a large supply of good nurses, the disease seems to have greatly abated during the last two weeks, and the hope is entertained that it will soon have run its course."[74]

435 cases, with 213 deaths from cholera had been reported in Santiago, Chili, up to February 15th. The disease raged with terrible effect in Chili and departments of Aconcagua, Indies, and Quillota.

In India, cholera has prevailed very extensively during the year. It spread northward, westward, and southward. Several epidemics were reported from Central India, and seventeen districts of the Bombay Presidency were visited. The disease also prevailed severely in Burmah and in Singapore. It has been reported from Kabul.[75]

Etiology of Cholera.—Klein[76] asserts that the importance of the comma-bacillus in the water produced in cholera is in direct

opposition to the known facts. He points out that it is extremely rare to find the mucous-flakes of the cholera stool free from bacteria, in addition to the comma-bacilli; and while he admits that Koch's bacillus has undoubtedly a stronger claim to be considered the positive germ of cholera, he denies such power to either of the micro-organisms named.

Dr. Klein thinks that "the well-known dependence of the spread of cholera on seasons is irreconcilable with the facts that are known concerning the comma-bacillus. The comma-bacilli grow and multiply at all temperatures between 16° and 40° C. I have had good cultures growing at 16° C., and therefore the months of August, September, October, and November in India would be extremely favorable. In the south of Europe, March and October, or even February and November, would be quite favorable, yet these are, as a rule, the very months when epidemics of cholera are rare, and where they do occur, they occur as a rule between the end of April and October. The epidemic in Europe in 1883, the very epidemic that preceded those of Toulon and Marseilles in 1884, approached its end by the end of October."

The fact remains, however, that the weight of opinion at this day is with Koch.

Propagation of Cholera.—Dr. C. Keith Aïrd,[77] of Berlin, after a discussion on the distribution of the disease by vessels, points out, that, while the interests of science demand the detailed report of every case, those of commerce, of seaports, etc., lean to suppression of existing cases. He gives a striking example in the case of the steamer *Corunna* or *Dorunda*, where 35 cases with 10 deaths occurred within a few days, the fact being simply passed over in silence after the first publication. The views upon the spreading of cholera are up to date generally based on reports from war vessels, and the importance of obtaining data from merchant vessels is pointed out. The poison reaches the ships by three routes: (1) By passengers in apparent health, yet carrying the germ of the disease; (2) in the provisions, and (3) in the freight. In the first case experience teaches that the disease dies out soon after leaving port. In the second case, the drinking water has been accused, and perhaps justly so, as the possibility of existence of the germ in drinking water can hardly be doubted, and as the comma-bacillus has repeatedly been demonstrated in

Indian ponds. He therefore urges strict supervision of the drinking water supplied to ships. If the provisions are the source of infection, and cholera appears after the vessel has left port, the nearest port should be made at once, in order to take means for protection. The case is different with freight, as *e.g.*, fresh hides, such as are exported in quantities from the East Indies. It is possible that the sailors may not come in contact with such freight, Coolies being generally employed in the handling. Hence it may be possible that a vessel, which has not had a single case of cholera on board, may carry the disease to Europe.

Emigrant and transportation vessels, being more fully manned and frequently overcrowded, afford a favorable soil for dissemination of the disease, and to this is added the change of diet, to which the landsman is subjected on board ship; and furthermore the fact that the preserved meat issued is frequently spoiled and unfit for food.

He gives a letter of an engineer on board ship, which bears out the idea of the causal connection between violent diarrhœa and spoiled preserved and salted meat.

He insists upon the necessity of supplying all vessels, especially those crossing the torrid zones, with good provisions, including pure drinking water. He holds that if a physician be appointed for service upon a merchantman, he should be appointed by the Government, and not by the owners of the vessel.

The great point in the author's opinion is, that the inhabitants of exposed coast districts should see to their own protection and thus to that of the cities inland, by strict attention to cleanliness, especially in preventing pollution of the water in their rivers and harbors.

The remedy against cholera he concludes is cleanliness and strict attention to diet.

Prevention of Cholera.—As regards the prevention of cholera one of the most striking examples of the effect of sanitary precautions was observed at a colliery on the island of Takasima, Japan, where cholera last year attacked 1500 out of 4000 laborers, and 800 died. As this present outbreak was the third time the island had been ravaged by cholera, the company took sanitary precautions, which are reported by the United States Consul, as follow :—[78]

"The port of Nagasaki was officially declared free from Asiatic cholera November 6. The epidemic of the present year in Nagasaki Ken, owing to the speedy and vigorous restrictive measures adopted by the Government, was not so severe as last year. In 1885, from August 13 to November 14, practically the limits of the duration of the disease, there were 4435 cases and 2927 deaths. This year, from August 9 to November 6, there were 2384 cases and 1551 deaths. While the character of the disease was as severe and the percentage of deaths about the same as last year, being about 65 per cent., the number of persons attacked is less by over 2000. At Takasima Colliery, on the Island of Takasima, near Nagasaki, the point at which last year the epidemic raged with great severity, of the 4000 men employed in the mines 1500 were attacked and 800 died. As this was the third or fourth time that the island had been ravaged with cholera, the owners of the mines, the Mitsubishi Company, determined to try such preventive means as modern science could suggest. A complete sewerage-system was formed. Heavy pumping arrangements were erected on the beach, for pumping sea-water to the highest point of the island, whence by an arrangement of drains and sluices it was gravitated back to the sea, flushing for three or four hours daily every drain among the dwelling-houses. An extensive fresh-water condensing apparatus was erected, turning out from 7000 to 8000 gallons of water per day. The wells on the island were closed, and water from the mainland only allowed to be imported for purposes of washing, etc. A strict system of food quarantine was instituted, and all food was supplied through the company. Three digesters, each of 800 gallons capacity, were erected, beef killed under inspection being used to make soup, about 1000 gallons per day being supplied to the miners. Beef was also served out in the rations. All shell-fish were prohibited, only deep-water fish, after inspection, being allowed to be landed or sold. No deleterious vegetables of any kind were permitted to be brought to the island,—potatoes, beans, and certain harmless native vegetables being the only ones allowed for consumption. The success of the system adopted has been amply demonstrated by the fact that Takasima has been the only place in Nagasaki Ken untouched by cholera during this year's epidemic. The treatment used by Dr. Nakamura, the chief surgeon of the mines, was remarkably successful.

The proportion of deaths to cases in the city of Nagasaki was about 90 per cent. In Takasima it was only about 50 per cent. Dr. Nakamura depended greatly on spirits of camphor and morphine in the initial stages of the disease, (even to the subcutaneous injections in severe cases), and on morphine and atropine in the collapsed stage,—in this stage the morphine and atropine being injected. He reports an interesting case, which occurred this year, on the neighboring island of Nakenosima, in which a cholera patient was kept alive and restored to health who had been for forty-eight hours without a perceptible pulse. He is emphatic in requiring abstention from liquors by the patient in the fever stage of the disease. While the cholera experience of 1885 has not been repeated in Nagasaki and vicinity in 1886, the epidemic has raged with virulence in other parts of the Empire of Japan. In 1885 there were altogether 11,927 cases and 7152 deaths, the proportion of mortality being about 60 per cent. This year (1886) there were 154,373 cases and 101,695 deaths,—a proportion of about 66 per cent. We may say that the cholera in Japan during the past year has spread widely, has been exceptionally severe, and the percentage of deaths enormous. The mortality is appalling when we consider that the disease has been combated with unusual activity, and with all the resources of modern science."

Diphtheria.—Virchow, as member of a special committee of the Silesian Society of Breeders of Fowls, stated "that the identity of the various diphtheritic pathological processes has not even been decided as to man. Even pharynx-diphtheria appears under so many different conditions that it is by no means certain that we deal with the same disease in all cases. Thus simple diphtheria may pass to the larynx, producing croup. There is also some diphtheria in scarlatina, smallpox, malignant phlegmon, undoubtedly connected with these diseases. We find diphtheria of the large intestine in dysentery, as well as in cholera, yet we cannot assume the identity of dysentery and cholera, or the production of pharyngeal diphtheria by intestinal diphtheria. The relation of diphtheria in animals to that in man is still more doubtful. It not only occurs in birds, but in calves also; yet the proof has not been supplied to show their identity in every case. The report of the society is characterized by an editorial writer[79] as unscientific, giving but one side of the question. The only fact being, that as

yet we have not been able to produce by culture a certain micro-organism as bearer of the disease under all conditions.

The contagious nature of the disease is well known, but during an epidemic among men, fowls are not specially endangered, nor is the reverse the case. The same is true of diphtheria and diphtheritic dysentery.

The only case to be noted in the society's report is published by Prof. Gerhardt. During a severe chicken epidemic, a man contracted traumatic diphtheria from the bite of a diseased chicken. Two-thirds of the workingmen also and three children of one of them had pharyngeal diphtheria. Wound infection has nothing to do with the question. But while in the other cases the transfer appears to have been made in the usual manner, yet we would desire further proof in order to justify far reaching sanitary measures. The investigations of the Imperial Sanitary Office have demonstrated the possibility of the transfer of chicken diphtheria to other animals, but also that there are several differences between it and the contagious diphtheria of man. In any rare cases the health of man may be affected by transfer of noxious materials from diphtheritic birds; but experience shows that epidemic diphtheria can not be traced to epidemic diphtheria of birds.

Dr. Emmerichs' work, showing identity of the diphtheria of pigeons and of man, is taken as a basis for the demand for legal measures referring to persons engaged in slaughtering and preparing diphtheritic-croupous animals, in order to afford protection against these epidemics. Virchow holds that such measures are as yet not demanded and that they would prove a great burden to agriculture. In fact, an attempt to include chicken diphtheria in the law for prohibition of animal epidemics, would prove impracticable, for then every single case of diphtheritic disease of a chicken or pigeon would at once be considered suspicious.

Two things, leaving legal regulations out of the question, are deemed possible:—

1. Instruction of those interested. This would best be attained by a publication of the facts in agricultural journals.

2. The inspectors of meat could be directed to forbid the sale of slaughtered diphtheritic animals,—not only birds, but calves also.

This is possible under existing laws relating to food substances.

Yellow Fever.—Yellow fever has prevailed during the year

on the Brazilian and Caribbean sea-coast, and various points on the Gulf of Mexico. It was introduced into the United States from Havana, Cuba, and effected a lodgment at Key West and Tampa, Florida, where it prevailed until the close of the summer season.

The investigation of the methods of Freire and Carmona for the prevention of yellow fever by inoculation is now going on, Dr. Geo. M. Sternberg of the U. S. Army having been detailed for that investigation.

Scarlet fever has prevailed extensively in England and in many parts of the United States. Its origin in several cases has been traced to the milk supply. The reports of the various outbreaks during the year are voluminous; but no new discoveries are reported.

Typhoid Fever.—At the Congress of Hygiene, September, 1887, M. Brouardel[80] opened the discussion on the mode of propagation of typhoid fever. He referred to the discovery of Eberth in 1880 of the bacillus of typhoid fever in the organs which were usually attacked. Koch, Gaffky, Coriul, and Babés have confirmed the discovery of Eberth. They found the specific bacilli in the organs of persons dying of typhoid fever, but they never found them in individuals who died of other diseases.

In 1885 Pfeiffer found typhoid-bacilli in fæcal matter, and cultivated them by gelatine plates during an epidemic which prevailed at Wiesbaden.

Brouardel was sustained in his opinion that the vehicles for the transmission of typhoid fever germs were, water, air, and clothing in contact with the sick; that the great source of the transmission of the disease was the pollution of drinking water. The amount of space allotted to this section is not sufficient to recapitulate the number of places where epidemics of typhoid fever have been traced to drinking water and milk, and the other vehicles of contagion mentioned by Brouardel.

Few diseases are more widespread in their character, or prevail over a greater portion of the surface of the globe. Newly settled countries are not exempt, as, if the present theory of origin be correct, it could not be expected that the climatic conditions of any particular place could act as a preventive of the transmission of the disease.

(*See also* WATER, and the statement concerning the Ohio epidemic under the topic of "Water.")

Plague.—A physician attached to the Russian Army[81] states that ninety per cent. of the Russian troops on the Asiatic frontier have been afflicted with boil-like eruptions on the body without injury to the general health, but still preventing active frontier service. From four to six months' residence seems to be all that is necessary for the development of boils. The plague itself, he declares, is produced by a bacillus existing in the air of the valley, and by means of dust it attaches itself to the clothing, and is inhaled by the soldier. Micrococci of plague originate in water. One drop is estimated to contain a million of them. The Imperial deputy observed and examined 300 cases of the plague, and states that the application of parasiticide remedies are absolutely necessary to keep the troops on the frontier of Asia capable for service.

Measles.—Dr. Geschwind's work shows measles to be contagious before eruption.

Epidemics in France.—A valuable treatise has been written by Dr. Coffee on the epidemic of cholera in the Department of Finistère. No proof of transmission by air, but by means of water. Clothing should be burned or washed in boiling water. A woman picked up in her apron straw from the mattress of a cholera patient, and carried it into a stable. On the following day she showed symptoms of cholera and was a corpse twenty-four hours later. The poor and alcoholic are most often attacked; the rich most seldom.

The epidemic character of diphtheria is rapid, the vital faculty of its contagious matter being wonderful. Dr. Darolle treated a fifteen months' old diphtheria patient lying in a cradle wherein two children had died of croup two years ago. Darolle observed that diphtheria was carried in blankets which peddlers had exhibited for sale in afflicted houses. Isolation is strictly to be observed, schools closed, and authorities to be informed.

Lastly, Dujardin-Beaumetz reports interesting cases of the epidemic appearance of inflammation of lungs, jaundice, miliary fever carried by midwives. Dr. Gibert, of Havre, thinks that every midwife should legally be prevented from exercising her profession for six weeks after the death of a miliary fever or

peritonitis patient, as is the case in England. Midwives in thickly populated districts should be provided with antiseptic fluids.

Dr. Mauricet describes a sort of St. Vitus' epidemic in a school conducted by a religious order, which is an addition to the chapter on physical contagion.

As a matter of interest, the editor of this section appends tables showing relative prevalence by months of cholera and yellow fever in 1887. The table was compiled from such reports as were on file in the Marine Hospital Bureau. They, however, do not cover all the cases of the disease during the year.

Yellow fever was present in the following named places during the year ending December 31, 1887:—

DEATHS.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Acapulco				1									
Bahia		2											
Cape Charles Quarantine*													
Cienfuegos									5	23	7	3	
Cucuta†													
Delaware Breakwater Quarantine								1					
Egmont Key							1						
Guayaquil	48	59	91	29	9	4						1	
Havana	1	16	10	21	65	118	76	64	50	35	24	10	
Key West					4	15	21	21	3				
Kingston (Jamaica)				2									
Many Lakes (Fla.)										1			
Maracaïbo								1			3	2	
Martinique									2				
Meredia					4		1	3	2		1		
Manateo†													
New York Quarantine*													
Palatka	3	6											
Para	9												
Pernambuco	2												
Rio Janeiro		9					1	2	1	2	1		
Santiago de Cuba	3									283	10	3	
Ship Island Quar.*													
Sapelo Quarantine*													
Tampa										34	38	2	
Vera Cruz										1			
	66	92	101	53	82	137	100	92	63	379	84	21	1270

* No cases taken to hospital. † No report of deaths.

Cholera was present in the following named places during the year ending December, 1887:—

DEATHS.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Calcutta	370	75	183	340	138	67	31	64	29	56	19	. .	. .
Catania	. .	51	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Esseg	6	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Hiogo	. .	. .	1	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Malta and Gozo	. .	. .	. .	. .	. .	. .	. .	. .	. .	295	. .	. .	. .
Mendoza	45	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Messina	. .	. .	. .	. .	. .	. .	. .	3	23	. .	. .	. .	. .
Naples	. .	. .	. .	. .	. .	. .	. .	25	145	18	. .	. .	. .
Ning-Po	. .	. .	. .	. .	. .	. .	. .	. .	. .	200	. .	. .	. .
Palermo	. .	. .	. .	. .	. .	. .	6	240	170	17	. .	. .	. .
Rome	. .	. .	. .	. .	. .	. .	. .	5	56	16	. .	. .	. .
Tetra Alba	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	12	. .	. .
Tivoli	. .	. .	. .	. .	. .	. .	. .	18	. .	. .	. .	. .	. .
Aconcagua	40	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Andes*	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Buenos Ayres	. .	376	. .	7	. .	. .	. .	. .	. .	. .	. .	. .	. .
Chili*	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Montevideo	83	37	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
New York Quarantine	. .	. .	. .	. .	. .	. .	. .	. .	. .	14	. .	. .	. .
Quillota*	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Rosario	13	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
San Felipe	40	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Santiago	. .	213	35	4	. .	. .	. .	. .	. .	. .	. .	. .	. .
Talca*	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Tucumon	250	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Valparaiso*	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
	847	752	219	351	138	67	37	355	423	616	31	. .	3836

* Not stated.

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[Undated references apply to journals published in 1887, and original articles can be found by consulting the indexes of the respective publications.]

THE DISPOSAL OF THE DEAD.

By JOHN G. LEE, M.D.,

PHILADELPHIA.

EMBALMING AND THE PRESERVATION OF PATHOLOGICAL SUBJECTS.

"If we cannot save our patients, we can at least preserve our subjects," is the theme of a memoir recently presented by Laskowski[1] to the Academy of Medical Sciences of Geneva, and crowned by that body. For, despite the recent advances of modern science, man, dubious of the immortality of his imperishable soul, seeks, in defiance of the laws of nature and the fiat, "dust unto dust, and ashes to ashes," to render imperishable his tenement of earthly clay. Thus it is that, apart from the useful preservation of anatomical specimens, the practice of embalming still meets with occasional supporters in all civilized countries. Fortunately, but little practical result follows, for, according to Eassc, Dr. Latour emphatically remarks, that if the human race had for the last three thousand years practiced embalming, there would not be to-day a portion of the earth's surface unoccupied by mummies. Though the regulations of the Georgia State Board of Health, regarding *cadavera* for dissection, provide that after a body has been received by any medical college, it must be embalmed and kept untouched by the knife for a period of sixty days, during which time it may be reclaimed by any relative or friend and interred, embalming cannot be considered of frequent occurrence in the United States since the civil war.

Originating with the Egyptians, who crudely eviscerated the subject, stuffed it with aromatics, and bandaged it with clothes saturated with aromatic gums and oils, the body—thanks to the dryness of the climate of the Nile basin—was thus preserved long enough for desiccation to take place, when putrefaction became impossible. Later, during mediæval times, it was resorted to on principles differing but slightly from those of the Egyptians. It was not until 1835, that Dr. Franchina, of Naples, and, at almost

the same time, Lauth, of Strasbourg, conceived the idea of forcing preservative fluids into the blood-vessels, since which time nearly every drug supposed to possess antiseptic properties has been tried in turn.

Formerly (and probably even now-a-days), in order to perform an embalmment skillfully and with entire success, an experienced surgeon was required. In this country, nearly every funeral director operates as an embalmer, at times very successfully. Relying upon previous personal experience, most of them have their own special injecting fluids, which they use in preference to all others. Such fluids are innumerable. The famous Gannal, of Paris, used arterial injections of a saturated solution of neutral sulphate of alum. Laskowski announces, as the ideal preservative injection, a solution first devised by himself in 1864, consisting of glycerine, second grade, 100 parts; carbolic acid, 5 parts. From 4 to 6 litres of this solution usually suffice, and cost eight to ten francs. A somewhat cheaper fluid, which answers very well, is glycerine ambrée, 100 parts; alcohol (or water), 20 parts; carbolic acid, 5 parts; crystallized boric acid, 5 parts. Cadavers injected in this way do not decompose for several months. For the most perfect form of embalmment, this fluid consists of 7 litres of pure glycerine; 250 grammes of carbolic acid; 500 grammes of chloride of zinc; 1 kilogramme of absolute alcohol; and 250 grammes of corrosive sublimate. These ingredients must be carefully mixed together with such essences and tinctures as may be desired to produce an agreeable odor and color; in order to avoid rupturing the blood-vessels, the injection must be skillfully performed. The brain, Laskowski[2] suggests, may be preserved, after cleaning, by a fluid consisting of 20 parts of alcohol, and 3 of boric acid, to 100 parts of water. While soaking in this solution, the meninges are removed, and after five or six days the brain is put into a saturated alcoholic chloride of zinc solution, and, after a short treatment, into the already mentioned mixture of carbolic acid, alcohol, and glycerine, after which it can be preserved and hardened in the open atmosphere.

For the preservation of the human corpse for scientific or legal purposes, Wickersheim,[3] of the Berlin Anatomical and Medical Museum, prefers a fluid as follows: Caustic potash, 60 parts; arsenious acid, 10 parts; dissolve by heat in 500 parts of water,

then add enough water to make 3000 parts, in which dissolve alum, 100 parts; salt, 25 parts; saltpetre, 12 parts. After cooling, filter. To 10 litres of this neutral, colorless fluid, add 4 litres of glycerine, and 1 litre of methylic alcohol. The body is to be injected with the fluid, and immersed in it for a few days, then rubbed and dried; the subject is to be enveloped in a sheet soaked with the preservative, and placed in an air-tight receptacle.

Dr. Tilton,[4] United States Army, differs with Wickersheim, and advises the following formula: Solution of chloride of zinc (U. S. Ph.), 1 gallon; solution of chloride of sodium (℥vj. to Oj.), 6 pints; solution of bichloride of mercury (℥j. to Oj.), 4 pints; alcohol 4 pints; carbolic acid (pure), ½ pint; carbolic acid dissolved in glycerine, 1½ pints. All these ingredients should make a clear solution of 3 gallons. For preserving human bodies, 2½ fluidounces for each pound is a safe estimate. If an artery is used, the injection should be toward the capillaries, and if a vein, toward the heart.

Bouchard and Bearnis,[5] of Bordeaux, indicate the following as the preservative injection in usage at their Anatomical Institute: Hydrated borate of soda, 10 parts; glycerine (sp. gr., 30° Baumé), 7 parts. Reduce the soda to a very fine powder, put it in a basin, and pour in the glycerine little by little to make a complete mixture, which must be warmed up to 80° Centigrade. Then put in a sufficient quantity of alcohol to make this mixture fluid. The injection is practiced in the carotid or femoral arteries. In subjects having already undergone a *post-mortem*, the four extremities should be injected. This liquid is said by its inventors to render dissecting wounds harmless.

Imada,[6] of Japan, has also obtained good results with the following fluid in injecting *cadavera:* ℞. Starch, ʒxx.; water, f℥xx. Mix thoroughly and add the following, prepared as directed: Wheat flour, ℥iij.; vermilion, ℥ij. to ℥iij. Mix these articles in a dry state, triturate together, and add water, f℥iij. After injecting this mass the following should be injected in order to prevent decomposition: Carbolic acid, ℥iij; glycerine, f℥iss; water, f℥iij.

Grawitz,[7] of the Berlin Pathological Museum, speaks enthusiastically of the following pickling liquid, which he has been using for the past two years: Common salt, 150 grammes; sugar, 40 grammes; saltpetre, 20 grammes, dissolved in 1 litre of water,

and the solution acidulated by the addition of three per cent. of boric or tartaric acid. The pathological specimen is placed in this fluid, and water is added until the object sinks in it; the vessels should be filled brimful, so that when the cover is placed on, no layer of air should be between the cover and the liquid. The pickle is usually ready in from four to eight weeks.

Besides the foregoing and many other already well-known methods of conserving the human cadaver and pathological specimen, it is said that a well-known physician and chemist of Padua, G. B. Massedaglia,[8] now dead some forty years, discovered a process for petrifying animal bodies, which he kept a secret, and which as yet his heirs have not seen fit to reveal.

Kergovatz[9] proposes to replace ordinary inhumation, cremation, and embalming, by galvanoplasty; which he claims has given him the most satisfactory results. The subject, covered with a layer of plumbago, is immersed in a bath of metallic solution of either copper, zinc, silver, or gold (according to the wealth and station of the deceased), and containing a piece of the metal to be used. To this is attached the positive pole of a strong battery. The negative pole is applied to the body, and at once a fine film of metal begins to cover the latter entirely and evenly. This may be continued until the coating attains any degree of thickness. This curious and remarkable discovery needs for the present no comment as to its merits or demerits. Experienced anatomists and pathologists will easily see the latter.

In the absence, in most countries, of any regulations as to the epoch at which deceased persons must be interred, a time often deferred until decomposition has set in, it is interesting to know that a proper method for the deodorization of the dead is to fill the coffin with sawdust saturated with chloride of zinc,[10]—a cheap and efficient remedy.

INHUMATION, BURIAL REFORM, CREMATION.

While in prehistoric times primitive man may have disposed of the dead body by casting it into the sea, or by abandoning it on the surface of the ground to the fury of the elements and the ravages of wild beasts, there is abundant evidence to show that as the population of this planet increased in numbers and civilization, and as superstition—the precursor of all forms of religion—gradu-

ally developed in the minds of our primæval ancestors, it soon became customary, partly out of regard for the necessities of the living, and partly out of respect for the dead, to provide proper and appropriate resting places for the remains of those who had passed over to the great majority. Naturally, the mode of their disposal at first varied greatly, according to the customs of each tribe or nation and the climate and topography of the country occupied by them, together with the means of the deceased, and the wishes of their friends and relatives. The rocky soil of Attica, for instance, bare of trees, necessitated the burial in grave chambers of the majority of the inhabitants, while, on the contrary, in a wooded country, cremation would be thought preferable. In early times the Attic burial rites were of the simplest. The grave was dug by the nearest relatives and the corpse buried in it; whereupon the mound was sown with corn, by means of which the decaying body was supposed to be pacified. Indeed, even without entering into a lengthy disquisition on the burial customs of the ancients, it is impossible not to notice the superstitious awe and reverence which seem still the inevitable accompaniment of death, save in some of the most savage tribes whose anthropophagous customs announce a most determined spirit of utilitarianism. To watch over the rights of the dead, and to do him honor, so that his spirit might not wander restlessly on the banks of Acheron, excluded from the Elysian fields—this was the beautiful Greek custom sanctified by the precepts of religion; an honorable burial being, according to Plato, the most beautiful conclusion of a life prolonged to old age and surrounded by wealth, health, and the esteem of men.[11]

After the very earliest periods the burial-places seem to have been in the houses of the deceased themselves; this immediate contact with the dead, however, being considered unclean, burial-grounds were prepared outside the city walls both at Athens and Sikyon. Sparta and Tarentum had burial-grounds in the city in order (as the law of Lycurgus has it) to steel the mind of the youths against the fear of death. But cremation was usually adopted after a battle or pestilence, whenever a large accumulation of bodies gave rise to dangerous emanations, and it was also used to facilitate the return home of the remains of the persons who had died in foreign countries. The burial customs of the

Romans did not differ markedly from those observed in Greece. First, we have inhumation, followed by incineration, introduced it is said by the dictator Sulla, who feared that his body would be defiled by the people. And so on, were we to investigate fully all the literature of the subject as recorded in the able works of Easse,[12] Wickes,[13] and Erichsen,[14] we would find that, influenced thereto by imitation of their neighbors, or driven thereto by the increase of population, most nations, though they at first inhumed their dead, ultimately practiced cremation. Even in Rome and Byzantium, the centres of all civilization during the period of the decadence, it was performed by nearly all classes, the Christians included, until when hunted down by the myrmidons of the Cæsars and obliged to seek refuge in the caves in the country and the catacombs of the imperial city, they were forced to desist from a ceremony which, by drawing attention to their retreats, would have insured them captivity and martyrdom. But when, at last, that master politician of his day, the Emperor Constantine, in order to secure the supremacy of the empire, officially recognized and tolerated the sects,—thus unchaining against his incapable successors a force which he himself was barely able to control,—they emerged from the darkness of their holes in the ground, and as they gradually acquired strength, they increased their hatred of what was, by recollection of past persecutions. Both leaders and followers breathed anathema and vengeance against the practices and customs of their Pagan masters, until the collapse of the Western Empire and the darkness of mediæval ages hid from view the miserable quarrels of both oppressors and oppressed.

The modern ideas of incineration but prove that history moves in parallel lines, repeating itself over and over again in its grander feature, differing only from its previous performances in *mise en scène* and the individualized personality of the actors. "It is in strict conformity," says Frazer,[15] in his excellent paper, "with what we observe of the cyclical movement of ideas among men, that, in the nineteenth century, and after a lapse of two thousand years since the nations representing civilization indulged the practice, the advisability of cremation or burning the bodies of the dead should be earnestly discussed, and that its advocates should find in it a subject of great importance to the sanitary condition of all communities of persons." Notwithstanding Easse's

assertion that the scheme has met with some enemies, and that injudicious promoters of the system have not proved the least of them, there can be little doubt to the watchful observer that the public mind is undergoing a gradual change in favor of incineration. The horrors of decomposition in the earth are becoming better known by the public at large, while the physician knows but too well what horrible sights the smiling green mound or the costly monument hides from the eye,—putrefaction in all its forms, mummification, the formation of adipocere, while animal life teems and thrives in every form on the decomposing corpse. Méguin[16] has recently established the fact that the worms of the grave are not really worms, but the larvæ of insects, *Dipteræ*, *Coleopteræ*, *Lepidopteræ*, *Arachnides*, deposited in the cadaver, according to circumstances, either a few minutes or even two or three years after death, each species selecting its own particular form of decomposition. The evils of inhumation, intra-mural and extra-mural, have been experienced for many years, to the cost of many valuable lives, and commented upon by able writers, until at last, public opinion having crystallized upon the subject, the leading scientists of the day have come forward to demonstrate that in this period of bitter struggle for the survival of the fittest, it is the duty of the dead to make room for the living. Thus with Italy as its pioneer, with many countries both of the old and new world following her lead, cremation has been making rapid progress since 1874; though prior to that time isolated instances of incineration had occurred. Crematories have been erected in many of the principal cities of Europe and the United States, while societies have been formed to disseminate knowledge upon the subject and encourage its practice, and in those countries where such action was necessary, legislative consent to this method of disposing of human remains has been, or is about to be, obtained. Many have even added to the beneficial effects of their teachings by the force of their example, and by having their remains cremated have shown their preference for the purifying disintegration accomplished by fire, to the slow and unspeakably foul process of corruption in the earth. Foremost of all in the ranks of these advanced thinkers was the late Professor S. D. Gross, M.D., LL.D., whose cremation took place some years ago in the Le Moyne furnace, and attracted marked attention. Concerning this distinguished

man's views on incineration, the following anecdote, probably but little known, may possibly prove of interest. Among the many persons present when Dr. Frazer read his instructive paper before the Social Science Association in this city, in 1874, was Professor Gross, who, rising at the termination of the paper, said he would like to ask the lecturer a question. Upon being accorded the floor, Professor Gross stated that he desired to know whether the cadaver could not be destroyed by burying in quick lime? From the lecturer he received the reply: "That while such a process would undoubtedly destroy the soft parts, you would run the risk, should the body be brought to light in after ages, of having some one play with your skull." Possibly such a reply may have confirmed Dr. Gross's opinion as to what should be done with his body after his death.

Rapidly, however, as incineration has been received by the more intelligent of the people at large, it must not be thought that such progress was made without a fight. Many difficulties have been raised against its adoption; legal, medico-legal, religious, and sentimental objections have been raised against the practice. The laity, the bar, the clergy, and some physicians, who should have known better, have in turn had their fling at it. The limited space at our command will not permit us to reply to the purely sentimental obstacles which have been brought forward. They will probably receive their quietus at the International Congress on Cremation, which will meet at Milan, in April, 1888, for the purpose of discussing it in its many-sided aspects. Of far more importance for immediate consideration are the impediments which governments are apt to put in the way, its cost, and the best method of performing it. For instance, the Danish authorities have forbidden cremation on the strength of an old ecclesiastical law, passed in 1685, according to which burial is prescribed as the only way to dispose of the dead. As a crematory has already been erected in Copenhagen, the owners feel that they have a just cause of complaint that they were not earlier informed of the existence of this law.[17] In Brazil, on the contrary, an imperial decree has recently promulgated making cremation compulsory in all cases of death from yellow fever. The State will provide the crematory furnaces, and will pay all the expenses attendant upon this mode of disposal of the dead.[18]

The cost of the operation is an equally important factor; it has been found to reach as high as £10 in England. Le Moyne thinks that the average expense of the cremation plan would not exceed $20.00. It is, however, probable that in many cases the cost would exceed that amount, but even then the expenses would be far below those of earth burial in large cities, with all its ghastly pomp and mummery. Naturally much would depend upon the system employed to obtain the necessary heat. These systems are quite numerous at present. Sir Henry Thompson has suggested the Siemens furnace as the vehicle of volatilization, for the reasons that inferior fuel may be employed to attain a high temperature; that the object to be heated is not brought in contact with anything but the inflamed gases; that the attainable temperature is higher, and that the gaseous products of the body can be thoroughly decomposed and burned before their escape from the chimney. Frazer thinks that if the practice were to become general, reverberatory funeral altars would be erected in convenient places for the people, whenever the death-rate would justify the outlay; for if the poor are to enjoy the privilege of participating, the furnaces must be so liberally patronized that the fires may be kept constantly burning. He further adds that one economical plan of procuring heat would be to associate a cremation furnace with the large iron furnaces, and use their waste heat. Brunetti, Gorini, Venini, and Bourry, have each introduced their own apparatus and worked them with success. The reports of the coming Congress at Milan, upon these different systems will therefore be awaited with impatience. A movement has also been set on foot in Italy toward erecting in one of the principal towns an electrical crematorium. In this edifice the corpses will be instantly consumed by means of an intense heat caused by electricity.[19] The destruction of dissecting-room offal is also receiving due attention; the usual way of getting rid of it by burial, storage, cremation, by alkalies, by mincing it and throwing it into the sewers, by giving it to buzzards, and by boxing it up and sending it away, proving expensive and troublesome. H. C. Boenning,[20] of this city, thinks he has found the solution of this unpleasant problem by the use of the Gregory furnace. He finds the cost of fuel so small, with an entire absence of foul gas, and a minimum residue of ash, that he recommends such a furnace as an

indispensable accession to every school of anatomy. A large crematory has also been erected in the cemetery of Père La Chaise, in Paris, and will shortly be opened. Our friend, Dr. Brouardel, estimates that the furnaces will be able to consume 4500 bodies annually, which is said to be about the average number of corpses leaving the hospitals in Paris during the year.[21]

Thus far we have simply dealt with the important questions of inhumation and incineration, but between the two there lies a *via media*, suscitated by the friends of the former and the opponents of the latter, and in charge of an association with its headquarters in England, whose profession of faith is as follows: "1. The exercise of economy and simplicity in everything appertaining to the funeral. 2. The use of plain hearses or wheeled biers. 3. The disuse of crape, scarves, feathers, velvet trappings, and the like. 4. The avoiding of excessive floral decoration. 5. The discouraging, on the occasion of the funeral, as far as possible, of all eating and drinking beyond that of every-day life. 6. The meeting in the churchyard or cemetery instead of at the house of mourning. 7. The dispelling of the idea that all the club-money must be spent on the funeral. 8. The early interment of the body in soil sufficient and suitable for its ultimate elements. 9. The use of such materials for the coffin as will rapidly decay after burial; this method being in accordance with the laws of nature, and avoiding sanitary evils, while the practice of burying in almost imperishable coffins is fraught with danger to public health. 10. The substitution of burial plots, surrounded by coping, for family vaults. 11. The encouragement, on sanitary grounds, of the removal, in crowded districts, of the body to a mortuary, instead of retaining it in the rooms occupied by the living. 12. The impressing upon workhouse officials the claims of the poorest to proper and reverent burial."[22]

The sumptuary restrictions recommended are deserving of the highest praise, and if the people could only be encouraged to carry them out, or forced to do so, the health of communities might be materially benefited. Suitable mortuaries would prove a great benefit to the poorer classes, and should be erected in this country by the proper authorities, as is done in so many European countries. Perishable coffins are an excellent suggestion, as is also that of burial in plain earth. But, to our mind, it is too late

now to go back to the "earth to earth" burial, except in rural districts where overcrowding does not occur. Burial in the soil within and near our large cities pollutes the earth, the air, and the water; the earth has no time to destroy the germs of contagious diseases, and the air and water are, when infected, active agents in their propagation. In this city three cemeteries containing 80,000 graves are so situated as to be liable to drain into the Schuylkill, the drinking water of 1,000,000 people. The diarrhœa prevalent here during the Centennial Exhibition is said, by many eminent sanitarians, to have been caused by burial-ground water drunk by strangers unaccustomed to it. Prescott, of Michigan, says: "The purifying power of ground, like that of the air above it, is limited and easily overcharged. If ground air be loaded with more putrescent vapor than it can oxidize, then poison is carried through the porous earth." As to the idea that if cremation became general the museums of anthropology and of natural history would become bankrupt, it scarcely merits consideration. The chemical objection: Would not universal cremation rob nature of its supply of ammonia? can be answered in the words of Hæckel: "Natural science teaches that not one particle of matter has ever come into existence nor one passed away. While a natural body seems to disappear by burning, evaporating, decaying, or chemical combination, the coming into existence of a natural body, a crystal, a fungus, an infusorium, depends upon the different particles of molecular aggregations which existed before in a certain form or combination, assuming a new form or combination, in consequence of changed conditions of existence. But never has a particle of matter vanished, or even an atom been added to the already existing mass." And the time is not far distant when cremation, resorted to voluntarily by communities in antiquity, still obligatory in times of pestilence and war, will again be resorted to as the result of scientific forethought and sanitary teaching. During this century, the end of which is rapidly approaching, we have done much to improve the sum total of civilization at the expense of human life. It is now time the dead should make room for the living.

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ANATOMY OF THE BRAIN.

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NEW YORK.

Progress in brain anatomy has mainly followed the lines traced by the immortal Gudden. The cerebro-spinal fibre labyrinth is becoming unraveled, strand by strand. We appear to be on the eve of understanding not alone the topographical location of the various higher, lower and intermediate nerve centres, and of the tracts which bind them in co-ordinate union, and directly or indirectly with the periphery, but also their precise physiological rôle. Most of this knowledge has been obtained by the atrophy method, supplemented by a careful study of agenesies in the cases of monstrosities, and of secondary degenerations, ensuing from focal organic diseases of the adult brain. The well-established paths of voluntary motor control of the extremities, of the muscular sense, and of visual projection have been confirmed by a host of observations. The discovery of the road traveled by auditory impressions, the connections of the olivary nuclei, the minute relations of the posterior roots and derived tracts, as well as the oculomotor system, are in the main the results of researches completed in 1887. In addition to the remarkable results obtained in the anatomy of the nerve tracts, as found in man, comparative anatomists have furnished important corroborative data derived from a study of the same, or analogous tracts, in lower animals. Some of these results relate to the central apparatus of special sense. The illustrations adduced in several such instances prove to be remarkable confirmations of the atrophy method. Most fruitful in this field have been the discoveries made in the cetacean brain. The remarkable mammalia which lead pelagic lives, having lost their hind limbs and the free digital motion of the fore limbs, are found to have the pyramid tracts and columns of Goll absent. So far they illustrate and sustain the deduction of the Gudden school, by a sort of natural atrophy method; but to make up for this

atrophy, they exhibit an enormous overgrowth of those tracts and ganglia which are devoted to the reception and transmission of impressions from the labyrinth of the ear. There is thus established a natural hypertrophy experiment, as it were, which furnishes positive confirmation in every detail of the results of artificial atrophy obtained by Onufrowicz and Baginsky. But not alone in physiological cerebral anatomy have important facts been developed; discoveries have been made in the morphological field of brain anatomy, which more than realize the wildest dreams of phylogeny. Who would have dreamed that the obscure appendix known as the pineal gland, in which Descartes sought the seat of the soul, would turn out to be the primitive eye of the Cyclopean ancestor of the vertebrata? Yet this has been proven, and its ventral analogue, the pituitary body, may yet be shown to be what is as yet only surmised equally an ancestral relic, but of a primitive pharyngeal gland possessed by the same remote ancestor.

A. von Kolliker[1] has confirmed and extended the observations of DeGraaf, Spencer, Wiedersheim and Rabl.-Ruckhardt relative to the real nature of the so-called pineal gland. There is found in the skulls of extinct reptiles, such as the ichthyosaurus and Nothosaurus and amphibians such as the labyrinthodon, a foramen in the parietal region of the skull, connecting its exterior with the brain cavity. This has been identified in some recent reptiles; and what is known as the frontal gland—a structure lying under the skin, and over this foramen—has been found to be connected with the pineal gland through this foramen. In its embryological development the latter is an extrusion analogous to the primitive ocular vesicles. The body found under the skin of the head in the iguana and other reptiles would therefore be comparable to the eye,—the pineal body to the stalk of that eye. This eye, however, singularly enough is not of the type found in the vertebrata, but of the mollusca. It has lost its function, and the pineal gland, so-called, persists in the human brain—as the coccyx does at the end of the vertebral column and the appendix vermiformis in the intestinal tract—not to carry out any function, but as an effete relic of an earlier developmental period.

A minute study of the pituitary body has been made by Lothringer.[2] He finds that in men the direction of its pedicle in this body is cephalo-ventral, and that the same direction is followed

by the canal contained in it; whereas in the mammalia examined both the tubercinereum as well as the pituitary body are caudoventrad. He discriminates between the true cavity of the pituitary body and that of the infundibulum. He gives an accurate description of its shape and proportions. It seems that there is no proportion between the size of this body and that of the entire brain. The ox has the largest; next comes the horse; among the carnivora the lion leads; next comes the bear and the domestic carnivora. He agrees with Peremeschko in finding it composed of a cerebral and epithelial division. Each has its proper cavity. The epithelial or glandular portion contains the so-called cavity of the hypophysis; while the cerebral portion contains the infundibulum. Embryologically, the former is derived from the oral fossette, the latter from the primitive ventricle. The cerebral division is invaginated into the epithelial, so that the cavity of the latter on section appears like the body of the letter "H," and is more or less branched. He finds that the color of the pituitary body is not attributable, as Luschka thought, to the injection of nutritive blood-vessels, but to a special pigment. The intimate dove-tailing of the tubes which make up the epithelial portion with large blood-vessels from the pia indicates to Luschka that it is not an effete body, but one that still has a physiological rôle as yet unknown. The cells designated by him as "chromopile" have the reaction of the active cells of the stomach, of colored blood disks, and of certain nerve cells, namely: they reduce perosmic acid, and deeply imbibe both eosin and hæmatoxylin.

Very little of a novel character has been described in the surface anatomy of the brain aside from the two appendicular bodies just referred to. Gierke[3] has contributed a minute description of the fourth ventricle, correcting many of its errors. He finds that the calamus scriptorius is divisible into two portions, whose boundary is the prolongation of the obex; the mesal portion is a direct prolongation of the central gelatinous gray matter; the lateral part is the true ala cinerea. Immediately laterad of the ala cinerea, the pia is very strongly rooted, and in the angle between this region and the ala, there is a triangular depression, which he calls the three-cornered fossa. It is to be regarded as a collecting lymph reservoir. The pia, after bridging over this newly described space, covers the surface of the ala cinerea, but in so doing

becomes so extremely attenuated as to be scarcely recognizable. The ala (in the sheep at least) is therefore not covered by endymal epithelia, which latter extends mesad of the ponticulus. He further corrects some erroneous notions as to the relationship between the ala cinerea and the nidus of the pneumogastric nerve, which are in reality not continuous. There is always a boundary formed by large blood-vessels. A powerful connective tissue extends between the nidus and the peculiar half-nervous, half-lymphatic structure represented by the ala cinerea proper. The nerve cells found in this organ are quite different from those of the vagus nest, and resemble those of the tuber cinereum of Rolando. His figures are in some respects so ambiguous that the reviewer is not certain that he may not have confounded the hypoglossal and vagal nidi.

As regards the fundamental elements of nerve tissue, the most important contribution of the year is that by Forel.[4] This, the ablest of Gudden's pupils, has submitted the method of Golgi to careful tests at the laboratory of the Burghölzli Asylum, and in every important particular confirms him. His chief conclusions are:—

(1) The ramification of the protoplasm processes end blindly, and never anastomose.

(2) Every ganglionic element is, strictly speaking, unipolar.

(3) The fibrillar process which constitutes the neural pole is not unbranched; on the contrary it always ramifies. Its ramifications are distinguishable from those of the protoplasmic processes by their smooth and even calibre and great thinness.

Forel also confirms the startling but physiologically suggestive and plausible assertion of Golgi that there are two categories of ganglionic elements, one of which gives off what remains of its axis cylinder process after the described ramification to form the core of a medullated nerve fibre, while the other gives off no such fibre, but loses its substance in the fibrillar felt work of the gray substance. The large pyramidal elements of the cortex the Purkinjean, cells of the cerebellum, those of the anterior horn of the spinal gray, as well as of the cell nests of the motor cranial nerves are examples of the first category. The second category is represented as a rule by smaller elements. Many nerve fibres do not directly connect with ganglionic bodies. Golgi has seen such enter the gray from the white substance, and divide up in the fibrillar

net-work, thus contributing to the latter. This observation has been confirmed by B. Hollar[5] in lower animals. These discoveries in the minute relation of nerve elements, fibrils and fibres have an important bearing on the physiological theory of cerebration. Hitherto it has been assumed that the nerve cells constituted stations as it were in the nerve fibre transit, and, theoretically, it was supposed that every such element was connected with two nerve fibres,—one connecting it with the periphery, the other with the higher or associated centres. In place of this view, now seen to be erroneous, Forel offers the following simple and plausible fundamental plan of the central nervous system: Inasmuch as every sensory nerve fibre originates in a properly epithelial element, which is to be regarded as the essential ganglionic centre for that fibre, we will expect to find its ramified fibre division in the nerve centres, inverting the relations of the motor nerve, whose centre is in the nerve centres, and whose ramification is in the periphery. The fundamental criterion between motor and sensory cells would, therefore, have to be sought for, not in their greater or lesser size, but in their composition. The ganglionic element of a sensory nerve is peripheral, and of a motor, central. On one point he differs from Golgi. The latter regarded all cells of his "second category" as sensory; those of the first, as motor. Forel, however, cites the experiments of Ganser, who by dividing the optic nerve induces atrophy of the retinal nerve elements. Now, structurally, these belong to Golgi's "first category," showing that even such nerve elements may be sensory. Golgi and Forel agree in regarding the fine branching of the fibrils to have, in part at least, a nutritive object. If the first facial nerve trunk be torn out at the stylo-mastoid foramen, a total atrophy of the facial cell-nest results. If the nerve trunk be merely cut across at that point, there is a simple shrinkage in the size of the nerve root, and a lesser atrophy of the cell-nest. Forel happily compares this to the case of certain lower organisms. If the finger of a newt or the tail of a lizard be cut off, it may grow again, but if a greater mutilation occur, the animal itself perishes. The nerve cell is comparable to such a low organism; if its nutritive arms the processes, be divided near their peripheral termination, they could be reproduced, albeit in reduced bulk; if they be destroyed near the cell body, the entire cell dies.

Almost simultaneously, two discoveries in the minute structure

of the ganglionic element have been made, which entirely dispose of the old view that it is equivalent to a simple cell. Adamkiewicz[6] has succeeded in injecting spaces in nerve cells in such a way as to prove their intimate connection with the natural vascular channels; while Fritsch[7] found in the enormous cells developed on the dorsal aspect of the oblongata in Lophius Piscatorius (the angle fish) a regular system of blood-vessels ramifying in their protoplasm.

The minute organization of the posterior horns of gray matter in the cord has been the subject of several essays. Hans Virchow[8] finds that the caput gelatinosum is full of nervous elements. These resemble the smaller bodies of the cerebellar molecular layer and of its granular layer. They possess large nuclei which resemble those of a typical ganglionic cell and serve to distinguish them from glia cells. Their protoplasm is relatively sparse. Golgi[9] describes the gelatinous substance minutely, and finds that the portion situated in the posterior horn owes its peculiarity of texture to the following facts: it contains no medullated nerve fibres; the meshes of its glia are narrower. There is very little intermediate substance; while delicate nerve fibres and small nerve cells fill up the meshes; inasmuch as all these elements absorb dyes deeply, the intense staining of the caput gelatinosum is accounted for. So closely crowded are the nerve elements that the earlier supposition of a fusion of embryonic elements seems to be borne out; but careful observation shows that where these cells are so crowded that their nuclei look as if embedded in a uniform blastema, the cell outline can always be made out. Golgi further describes a column of supporting substance hitherto unnoticed, which extends from the periphery of the cord to the posterior horn. Previous authors, if they have observed, have classified it with gray substance; but as the gray color and staining are due to glia cells, and the only nervous elements in it are nerve fibres, it is to be regarded as belonging to the conducting substances. In addition, since it is full of large lymph gaps, it serves as a lymph emunctory for the juicy substantia gelatinosa.

While nothing new is to be recorded in the anatomy of the cell-nests in the anterior horn of the spinal gray, valuable and suggestive data have been obtained in our minute knowledge of the cell-nests of the cranial nerves. We proceed to summarize the present state of our knowledge regarding the nerves moving

the eyeball, largely obtained during the past year: The centres from which the nerves distributed to the muscles of the eyeballs take their origin are situated in symmetrical cell groups of the gray matter, lining the posterior part of the third ventricle, the aqueduct and the floor of the fourth ventricle. The interior, and largest of these cell-nests is that from which the third pair proceeds. Taken as a whole, it is located in the ventral part of the "central tubular gray," and comprises a number of subdivisions, the special relation of certain of which to special muscles is accurately known. The nest governing the pupillary motions is probably the most anterior.[10] That governing accommodative reaction probably lies on either side of the raphé in a group of numerous small elements, immediately behind the centre of the iris sphincter. The other groups are divided into two main masses, one mesad and caudad, which is the centre for the opposite rectus-internus. The other which is laterad is the centre for the rectus-superior, rectus-inferior, levator palpebræ and obliquus-inferior. The nerve fibres proceeding from these cell-nests converge toward the base of the brain just as the wisps of a broom are gathered together at the stem. The individual radicles maintain the relations which their nests of origin exhibit. Thus, the most interior supply the pupillary accommodative muscles. The posterior fibres supply the outer muscles, and among these it is the most posterior and internal which represent the rectus-internus and these are derived from the nucleus of the opposite side. In this course the pupillary and accommodative fibres do not enter the peduncle, except near their exit; whereas the other fibres of the third pair actually traverse the peduncle; this explains how a lesion of the peduncle may produce paralysis of the eyeball movement, and leave the movements of the iris and lens intact. Individually any one of these cell-nests (and this applies to the nuclei of the fourth and sixth nerve cells) can mediate only a partial movement of one eyeball,—motions of a kind which never occur in health. They are bound in functional union so firmly that unless the combination be destroyed by disease, no other movements can occur than those so usefully associated that both eyes are fixed on the same object, and able to follow that object whether it or the observer move.

To effect this union, numerous associating fibres exist, some of which demonstrated by the Weigert stain run into the nucleus

proper; while others constitute a compact bundle, the posterior longitudinal fasciculus of the tegmentum. This bundle runs from the neighborhood of the nidus of the third pair and dips ventrad of the nidi of the fourth and sixth nerves. It had been supposed in order to account for the harmonious action of the external rectus of one eye and the internal of the other in lateral motion that this bundle through a decussation which Duval and Laborde claimed to have discovered, united the centre of one third pair with the centre of the opposite sixth pair; but the discovery of von Gudden that the centre for the internal rectus is on the opposite side of the emerging nerve root, supplying it, does away with the necessity for such an explanation, and J. Nussbaum,[11] who has specially examined into the matter, fails to confirm the observation of Duval and Laborde.

It has long been noted by clinicians that in classical hemiplegia, those muscles innervated by the lower rami of the facial nerve are paralyzed with the extremities of the affected side of the body; whereas the orbicularis palpebrarum and frontalis escape. Different theories had been suggested by Broadbent, Legendre and Berger to account for this immunity, but they are dissipated by the discovery of a remarkable fact in nuclear anatomy by Mendel.[12] His attention was directed to the subject by the observation that in cases of bulbar paralysis with total atrophy of the cell-nests of the facial nerve the ocular branches of that nerve are not paralyzed. Slightly modifying Gudden's atrophy method, he destroyed in rabbits and guinea pigs eight to ten days after birth, both the upper and lower eyelids, as well as the frontal muscle on one side. After from five to ten months the animals were killed. All the muscles innervated by the third, sixth and seventh pairs were found normal, being found in the nidus of the facial nerve, it was found in that of the ocular motor, and limited to the side of the mutilation. Of the microscopic transverse sections of the brain axes of these animals the 35 cephalic ones, including the ocular motor nidi showed no asymmetry, the caudal sections showed differences as indicated in the number of cells stated in the subjoined table:

MUTILATED SIDE.		SOUND SIDE.
No. of Section.	No. of Cells.	No. of Cells.
36th	4	22
46th	16	42
57th	8	25

More caudad the left nidus was entirely absent, the right, still containing a few cells. Mendel believes that these palpebro-frontal fibres pass from the oculo-motor nidus to the root of the seventh pair as a component part of the posterior longitudinal fasciculus of the tegmentum. Although unable to demonstrate this fact with certainty, the reviewer is able to confirm the existence of a fasciculus which has the required course. There is a physiological reason for this close connection of the cell-nest related to the eye muscles and the cell-nest of the palpebral and superciliary muscles, for these are under the same reflex dominion of the retina as is the pupil. Mendel's discovery also harmonizes with the fact as obtained by Hitzig with regard to the cerebral cortex of the dog. Here the centre for the eye muscles and for the ocular division of the facial is a common one, and is distinct from the centre of the lower facial.

A minute topographical description of the nidus of the accessory nerve is contributed by Dees.[13] Briefly these facts are as follow: At the level of the first cervical nerve roots the radicles of the accessory nerve can be clearly traced from the gray substance to the periphery of the cord. They run in a single compact bundle, composed of large fibres parallel and near to the contour of the posterior horn, and before reaching the periphery of the cord break up into a sort of delta. The cell group from which these rootlets arise appears to lie in the middle of the anterior horn. To solve all doubts on this head, Gudden, under whose direction Dees' monograph was written, extirpated the spinal accessory nerve on one side, in two rabbits. The result was that the cell group, corresponding to the spinal accessory nidus of the human cord, was found to be absent. Closer examination revealed that the cells in question belonged to the large multipolar kind, having a diameter of from 30 to 40 micro-millimetres. In the lower parts of the cord the relations just described are somewhat changed. The root fibres, after coursing of the ventro-lateral, escape of the posterior horn, reach the re-entering angle between the lateral horn and the neck of the posterior horn to their curved caudad. At the same time the cell-nest gradually moves from its position in the centre of the interior horn just described toward the extreme lateral margin of the latter. In still lower levels, between the origins of the third and sixth cervical pairs the cell group moves

further dorsad, so that it is here located in the base of the lateral horn. A similarly thorough study has been made of the hypoglossal nidus and root by Koch.[14] He ascertained by the Weigert method that the roots do not decussate at all with those on the other side,—that there are commissural fibres connecting the nidi of opposite sides running ventrad of the central canal. He also claims that there are decussated fibres passing from the pyramid of one side to the hypoglossal nidus of the other, in harmony with Meyner's views. His more novel discovery is that there are fine associating fibres, connecting the cells of the nucleus in the cephalo-caudad direction, and running on its dorsal face.

The most radical change in accepted views, and perhaps the most important discovery tending to clear up the fibre labyrinth of the brain axes is connected with the question of the origin of the auditory nerve and the course of the auditory nerve tracts. Edinger[15] finds that the posterior division of this nerve (one which, through its connection with the cochlea is regarded as the proper nerve of hearing) is connected with the anterior auditory nidus. This nidus is connected with the opposite superior olivary body by a powerful bundle and with the corresponding body of the same side by a slender bundle. It is also connected by means of arched fibres which sweep around the restiform column with the inner auditory nidus. The anterior division which is regarded as a nerve of equilibrium originates from the central auditory nucleus, and the direct sensory cerebellar tract. By this unfortunately selected title Edinger designates Meynert's inner division of the cerebellar peduncle. This tract originates in the globulous embolus and the fastigial nidus, by means of rather dense nerve strands, which all lie mesad of the ciliary body. The direct sensory cerebellar tract of Edinger may be confounded with Roller's ascending root of the eighth pair, which the former regards as probably connected with the ninth and tenth pairs.

Examination of the cetacean brain shows (according to Spitzka[16]) that the medulla oblongata of these animals receives fewer contributory tracts than that of man and animals allied to man. This architecture is therefore comparatively simple from the cord up to the point of entrance of the auditory nerve in the projection system. Here every thing indicates a complete change. These enormous nerves (for in their aggregate cross-section they

exceed the area of the lumbar cord) revolutionize the entire facies of the pons oblongata transition and of the pons itself. In the first place the cross-section exposes a large transverse mass of fibres, exceeding the area of the pons, plus the rest of the tegmentum. An included complex ganglion is shown by its microscopic characters, its relation to the fibres surrounding and entering it and the course of the latter to the raphæ to be the hypertrophic trapezium (superior olive). In more cephalic levels a large field composed of fibres taking a cephalic course is noted to grow out of the region of the trapezium. This is identical with the lateral lemniscus, and is bodily absorbed in the posterior pair of the corpora-quadrigemina. The absence of other complicating tracts, the confirmatory observation of a similar relation in the seals and sea lions, who also possess large auditory nerves, show that the so-called superior olives, or, as they should be called, "nidi of the trapezium," the lateral lemniscus and the posterior pair of the corpora-quadrigemina, constitute an anatomical and physiological continuity. This supports Baginsky's[17] view based on an atrophy experiment undertaken in rabbits, for this author found the very parts which Spitzka states to be overgrown in the cetacea to be very atrophied in rabbits in whom the cochlear division of the auditory nerve had been destroyed. He thus sustains Baginsky in face of the objections of Forel,[18] who asserts that the posterior pair of the corpora quadrigemina can have no relation to the sense of hearing on the alleged ground that though they are absent in birds these animals have a good sense of hearing. This objection is fallacious, because, contrary to Forel's statement, not only the birds, but all the sauropsida, possess the ganglia of the posterior pair. Forel has simply overlooked them because they do not constitute plastic eminences as in the mammalia. The course of the auditory tract would now seem to be definitely established; for, beyond the point to which Baginsky and Spitzka trace it from below, von Monakow[19] has traced it by secondary descending atrophy, provoked by extirpation of the cortical field of hearing. In cats, such experiments were followed by an extreme atrophy of the internal geniculate body, and the arm of the posterior pair of the corpora-quadrigemina of the same side. A further confirmation of the correctness of this observation is furnished by Spitzka, who finds that the internal geniculate bodies in the cetacea

and seals are enormous. In the latter animals the fasciculus uniting them to the white matter of the hemispheres is macroscopically visible. Von Monakow[20] has further confirmed Baginsky by producing an atrophy in a descending direction in the course of fibres described by the latter. By extirpating the connection between the lateral (lower) lemniscus and posterior pair he produced atrophy in the cephalic part of the superior olive, and of the white matter of the trapezium dorsad of it. This atrophy could be traced in a caudo-medial direction to the raphe, and from here into the striæ acustici of the opposite side, as far as and into the acustic tubercle, where the atrophy involved both of the upper strata. Thus the connection of the white streaks at the floor of the fourth ventricle, which are such characteristic features of the human brain as compared with the animal brain, and which have been found absent or feebly marked in deaf mutes by Waldschmidt,[21] are shown to be positively related to the function of hearing and the auditory nerve. This militates against the results obtained by Fleschsig's method, which placed this matter in doubt. The renewed interest attaching to the superior olive or trapezial nidus justifies a citation of the more accurate description of this body as found in man furnished by Helwig. He finds that instead of being the obscure faintly marked mass described by Meynert and others, it is built up as in lower animals of three masses, a main and inner accessory and the outer accessory portion. He also finds that it extends further cephalad than has been thus far supposed, sending a prolongation like the neck of a bottle into the lemniscus.

The observations of this year in the field of visual projection are simply confirmatory of previous discoveries. The only novel registration relates to the anatomy of the fibres of central vision in the optic nerve itself. Theodore Sachs[22] in a case of central scotoma found that the part of the optic nerve undergoing atrophy is situated in the lateral ventral quadrant of the cross-section of the nerve, at the point where the nerve traverses the optic foramen. He is nearly confirmed by Uhtoff,[23] who finds that the atrophy of the optic nerve, which manifests itself in the pallor of the temporal part of the optic disc in alcoholic and other toxic paralyses is situated in the temporal periphery of the nerve near the eye, while behind the entering point of the central artery of the retina

it occupies a field slightly removed from the periphery, but in this same latero-ventral quadrant.

Of the great tracts the one thus far best studied and established (the pyramid tract) has been somewhat elaborated. Thus Ziehen[24] corrects and contradicts the startling claim of Sherrington that this tract undergoes redecussations. He finds that the fibres of the fore-leg cross entirely from the pyramid tract. They are the first to decussate in the cephalo-cordo direction and in the oblongata on cross-section lie dorsal-laterad. Tooth records a valuable observation of secondary degeneration in man, following transverse lesion of the cord at the level of the fifth and sixth dorsal vertebræ. Below this lesion only the crossed pyramid tract was degenerated. This proves that Bouchard, Gowers, and Westphal were correct in claiming that the direct pyramid tract is exhausted before reaching the middle dorsal cord. A number of recent observations would tend to show that the pyramid decussation properly so-called, embodies some fibres which do not physiologically belong to this tract, for in a cat in which he had produced complete atrophy of one cerebral hemisphere and the corresponding pyramid tract, Spitzka[25] found an attenuated bundle crossing into the atrophied side.

The pons has been studied by Yelgersma.[26] He finds the following connecting tracts can be discriminated. (*a*) From the frontal cortex to the cell-nests of the pons proper; these fibres are situated ventrad of the pyramid tract, and in the pes are represented in its most medial division. (*b*) From the temporal cortex to those ganglionic cells of the pons which lie between the pyramid and lemniscus tracts; they run in the lateral third of the pes. He believes that both of these tracts, through the intervention of the ganglionic cells of the pons, connect the pes with the opposite half of the cerebellum.

The observations of Bechtherew[27] based on cases of secondary degeneration are on the whole confirmatory of the preceding. He contributes the interesting observation that Turk's bundle was intact in a microcephalic idiot who had only the temporal together with the basilar part of the occipital lobe intact. The observations of Marchi seem to show that there is no direct fibre connection from the cerebellum to the pes, but that all such connection is indirect and mediated by the gray matter; for in his

experiments extirpation of only one side of the cerebellum in dogs and monkeys resulted in degeneration of the white and gray matter on the same side of the pons, and of but very few fibres in its opposite side.

A new tract, or rather an attempt to create a new tract, out of some imperfectly known segments has been made by Helweg.[28] While his descriptions are plausible, and in many respects tally with observations made by previous writers, yet it is to be borne in mind that they are based upon a very slight color difference observed in the white matter of the cords of certain patients dying insane. He regards this tract as having a vaso-motor function, but at present it is scarcely worth while following his rather fanciful theorization on this subject. Suffice it to say, these anatomical descriptions are very clear, and the drawings accurate. In the cord, this tract runs near the anterior nerve roots, encroaching a little upon their field. At the fifth cervical nerve root it gradually concentrates at the margin of the cord in a field which is triangular on cross-section, with prolonged angles. In the oblongata at the level of the pyramid decussation, it lies just dorsad of the pyramid in the ideal prolongation of the inner accessory olive. This tract may be regarded as a sort of core of a more scattered tract surrounding it, and which gradually passes into the halo or light area surrounding the olive, and both tracts are connected with the olivary nucleus, and continued in the ideal cephalic prolongation of the olivary nucleus by an oval tract which lies in the tegmentum of the pons level, mesad of the superior olive laterad of the cortex lemniscus and dorsad of the trapezium, with the long axis of the oval tilted mesad at its dorsal edge.

With regard to the direct cerebellar tract, the latest observations are calculated to render the accepted theory of its connection with the columns of Clark doubtful. Lowenthal[29] found after hemisection of a kitten's cord that the atrophy of the columns of Clark was manifest in those levels in which the cerebellar tract was intact, and furthermore that the former degenerated caudad and the latter cephalad. If confirmed this observation decidedly militates against the accepted theory. Zacher's[30] observation that the innermost fibres of the columns of Clark undergo secondary wasting in amputation of the thigh, on the other hand tend to support the attacked view. A systematic degeneration of the

cerebellar tract has been observed in two cases of paretic dementia by Fürstner,[31] who mentions a suggestive fact tending to support the views of those who regard these tracts as having visceral relations, namely, that both patients showed remarkably rapid emaciation.

It would seem as if the method of Flechsig employed to determine the relationship of nerve tracts by means of the chronological development of their myelin has reached its acme of usefulness, and that more accurate results and more novel discoveries must be made by the atrophy or degeneration methods. Nay, that even the accepted results of Flechsig's method require to be carefully and critically re-examined. An instance of this need is furnished by the case of the striæ acustici. Whether Bechtherew's[32] most recent observations obtained by this means are destined to stand is a question. He claims that the anterior peduncle of the cerebellum (Bindearm) is divisible into four bundles, which on cross-section are situated as follow: The smallest in the ventral division: it obtains its myelin in the fœtus of 27 to 28 centimetres in length. The second tract developed occupies the dorso-lateral part of the area, and is found in the fœtus of 33 centimetres. A third tract is found with a length of 35 centimetres, and fills up the remainder of the lateral half; while the largest and latest to develop occupies the mesal portion and is found at birth. The first of these tracts does not go to the decussation, but passes to the pons separately from the rest of the anterior peduncle. The second tract goes to the nidus of the fastigium and vermis superior; the third goes to the embolus and globulus; the fourth goes to the ciliary body or dentated nucleus.

The theory of Hamilton that the corpus callosum, instead of being the commissure, as which it has generally been regarded, is composed of decussating capsule fibres, unwarranted as it was by any reliable observations, has been overthrown by Edinger[33] and Onufrowicz.[34] The latter has made a careful study of the brain of a microcephalic idiot whose callosum was absent. Inasmuch as all fibres belonging to the callosal system were eliminated from this brain, it was comparatively easy to determine which were and which were not callosal fibres. It was found that the so-called tapetum and the lateral extensions of the forceps proper were not absent, showing that these are not prolongations of the callosum

The tapetum belongs to the association systems, and to that particular bundle which is known as the superior longitudinal fasciculus of the hemisphere. He further found that the callosum is not connected with the temporal lobe, so that there appears to be a sort of complementary relation between the anterior commissure and the callosum, the anterior commissure having the same relation to the temporal lobe which the callosum has to the rest of the hemisphere. In addition, Osborn[35] has shown that, contrary to the generally received opinion, reptiles do possess a corpus callosum. He singularly neglects to acknowledge the prior discovery of this same fact in the same group of animals, made by another American investigator.

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ANATOMY.

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THE anatomy of the various organs, special senses, brain, etc., having been fully treated under the departments of the various editors in charge of the diseases of those organs, we have thought it unnecessary to touch upon them here. We therefore give only the progress of the year upon such parts of the human organism as have not been alluded to elsewhere in the ANNUAL.

GENITO-URINARY SYSTEM.

Position of Uterus.—Herman,[1] of London, in a recent lecture upon the displacements and distortions of the uterus, defined its normal position as permitting mobility within certain limits, any position within those limits being a normal one. The uterus may therefore be anteverted or retroverted to a certain degree consistent with health. Neither retroversion nor anteversion is a normal state, and something more than the mere presence of these so-called displacements is required to warrant treating them as morbid. The uterus can be pushed up or pulled down, or pushed to either side; it can also be turned forward or backward, or bent forward or backward, by appropriate manipulations, without difficulty and without producing suffering. The limits of these movements cannot exactly be defined, being different in different subjects, according to the conformation and firmness of the structures to which the uterus is attached. In healthy women the shape of the uterus may be either straight as to its long axis or slightly curved anteriorly. But these shapes are not the only ones consistent with health. While it may be straight in virgins, in the majority it is bent forward, this bend varying indefinitely in degree. After child-bearing it is often found altered in shape. All intermediate degrees are met with between a uterus which is quite straight and one so bent that the anterior surfaces of the

body and cervix will be found nearly parallel, thus forming an acute angle at their junction. Any one of these shapes is quite consistent with perfect health and functional activity.

The practical value of Herman's studies on the subject hardly need comment. They point to what may be grievous errors, especially in operative gynæcology.

As to the manner in which the uterus is supported, Herman was led, by careful manipulation, to the belief that the pelvic fascia and the levator ani are its essential supports. The so-called uterine ligaments are in health never tense, so that they cannot act as ordinary uterine supports.

Interesting in this connection is the examination by Byford,[2] of Chicago, of the pelvic viscera of an infant three days old. The lower end of the cervix was decidedly to the left; the Fallopian tube, ovarian ligament, and broad ligament on the side toward which the uterus was placed, were shorter than the tube and ovarian ligament on the other side, showing that in this case the normal position of the cervix was to the left of the median line. There was also a slight persistent anteflexion. The rudimentary ovaries were almost against the uterus and the right was one and a half times as large as the left. The cervix extended considerably below Douglas' pouch. The uterus had a slight inclination from the cervix up toward the right and toward the median line, and thus already exhibited a slight lateral version.

In a careful study of the subject, Tschaussow[3] draws the following conclusions: (1) In the embryo the uterus, with its fundus and a part of the body, projects into the false pelvis. (2) Anteversion is the normal position, and is caused by the normal capacity of the pelvis. (3) Anteversio-flexion is the normal position for the age of childhood and for nulliparæ. (4) The curve is caused by the pressure of the iliac flexure and the coils of intestine on the posterior wall of the uterus. (5) In moderate conditions of flexion the position of the uterus corresponds more or less with the pelvic axis. (6) Filling of the bladder causes a turning of the uterus backward; in higher conditions of fullness the flexion decreases, and the uterus stands parallel with the posterior wall of the pelvis. (7) The urinary bladder is spindle-shaped in the fœtus and the newborn child, triangular in the adult. (8) The inner opening of the urethra corresponds, in the newborn, to the neck of the uterus and

it will be found a little above the os externum; in the adult, the development of the vagina places the inner orifice much deeper. (9) Freezing of the corpse in the upright position produces a downward sinking of the uterus and a shortening of the vagina. With regard to women who have borne children, the author sums up his conclusions as follow: (1) The normal position of the uterus in a woman who has borne children is parallel to the hinder wall o' the pelvis. (2) Douglas' pouch does not exist, since the uteru together with the ligamenta lata, lie close to the hinder wall of the pelvis. (3) The condition of fullness of the bladder exercises relative influence on the position of the uterus. (4) No influence on the uterus of the anterior wall of the vagina or the ligamenta utero-sacralia could be discovered. (5) Lateral version of the uterus corresponded mostly with the position of the rectum in the right half of the pelvis.

Lymphatics of the Genital Organs in the Female.—In a paper read before the Société Anatomique, Poirier[4] stated, (1) that he had not been able to find lymphatic ganglia around the neck of the uterus in any of the preparations examined by him, and that he therefore considered those reported by Sappey and Lucas-Championnière as exceptional; (2) that the lymphatics of the uterus proceeded towards and met ganglia situated at the bifurcation of the internal iliac and the external border of the broad ligament; (3) that they do not go in the direction of the subpubic arch, where ganglia are seldom found, the nearest being three centimetres posteriorly along the course of the obturator nerve; (4) that the lymphatics which start from the ovaries form an exceedingly rich plexus, and go to the lumbar ganglia; (5) that the uterine lymphatics sometimes follow the broad ligament as far as the inguinal ganglia, in which location Cruveilhier has seen enlarged glands, resulting from uterine cancer.

Persistence of Müller's Duct in the Male.—Reliquet[5] reports the case of a man aged 45, in whom an autopsy revealed two large ducts extending from the right kidney toward the bladder, one being a dilated ureter. The other, which originated at the upper part of the kidney, proved to be Müller's duct. An abnormal pouch was found in the bladder near the verumontanum, which was normal as to the orifice of the seminal ducts. The left ureter and Müller's duct opened within this pouch, while the right

opened outside of it. The fact that Müller's ducts are the origin of the female internal organs of generation make their presence in the male, in whom they are reduced to the verumontanum, exceedingly rare. This case is especially interesting through the fact that in almost every case so far reported, functional disorders incident to the abnormal condition had caused death in childhood.

Seminal Vesicles.—Carter,[6] after considering all the known facts in connection with the seminal vesicles, does not believe them to be a mere reservoir for semen, an opinion previously expressed by Hunter, but that they have their own proper secretion and store up a fluid which acts as a medium and diluent to the fluid formed by the testicles. During ejaculation the obliquity with which the seminal vesicles join the vas deferens to form the common ejaculatory duct, favors both the mixture and expulsion of the fluid contained in them into the urethra.

The Muscles of Wilson and Guthrie.—Cros,[7] after careful research, concludes that the so-called muscles of Wilson and Guthrie are but annular fibres, which may be also found, and in greater number, in the portion of the urethra under the subpubic ligament; and that their identity as separate and distinct muscles is questionable.

DIGESTIVE SYSTEM.

Floor of the Mouth.—Suzanne,[8] in an elaborate paper in which he gives the results of a study of the anatomy of the mouth in 40 dissections, describes a hitherto unpublished glandular group, quite distinct from the sublingual gland, which he found in each of the 40 cases. The group was composed of particles varying in size from a hemp seed to a millet seed, and forming by their agglomeration a gland about as large as a pea, but varying in this particular in different individuals. It is situated in the middle line, immediately behind the posterior surface of the inferior maxilla, at the level where the mucous membrane of the floor of the mouth is continuous with that of the gums, and it is on a more superficial plane than the sublingual gland. The naked eye can distinguish no excretory duct. Microscopically, the lobules present the structure of a mucous gland.

Valves in the Gastric Veins.—It is generally believed that the portal vein is not furnished with valves. Hochstetter[9] lately reported a series of studies in the newborn child, during which he

found valves in the gastro-epiploic veins and in the short gastric, their object being to oppose the return of blood to the stomach. The gastric veins alone possess valves, the pylorus forming a point of sharp distinction between the valvular and non-valvular veins. Although similar to those in the veins of other portions of the system, the valves in the gastric veins are much more delicate. As age advances they become more and more insufficient, until about the twentieth year, when no competent valves are to be found along the greater curvature.

Position of the Stomach.—Leuf[10] calls attention to the fact that the long axis of the stomach when distended, is not horizontal as is generally believed, and as shown in Gray's Anatomy, but oblique. When empty and therefore contracted, the "tubular" shape is assumed by the organ, the œsophageal orifice and pylorus approximating the perpendicular much more than generally thought in the relative position to each other. This position is maintained during distension, the position and angle of the lesser curvature remaining undisturbed, while the larger curvature alone yields to the pressure of the ingesta. The distensile changes of the viscus manifest themselves, therefore, toward the left side to a much greater degree than is generally believed.

Sphincter at the Mouth of the Ductus Choledochus.—Oddi,[11] of Perugia, noticed after detaching the biliary vesicle, that the ductus choledochus became transformed into a reservoir of bile, and discovered a muscular layer the fibres of which formed a perfect sphincter around the orifice of the duct. Its object is doubtless to regulate the flow of bile into the intestines and to prevent regurgitation of fluid into the biliary tract. Glisson had previously suggested the presence of this sphincter without, however, demonstrating its existence.

OSSEOUS SYSTEM.

The Third Trochanter.—Treves[12] reported two markedly developed third trochanters observed during life in a man of 50, the bony outgrowths following precisely the gluteal ridge of the femur. "It was quite smooth, projected directly backward, and appeared to be about one inch in height and half an inch in width. It was no wider at the base than at the free border; and this edge was perfectly distinct, even and rounded. When the gluteus maximus was brought into action, the fibres of the muscles were found to be

inserted into this ridge, and during the contraction of the free border of the bony mass was rendered indistinct. Both femora were marked by like projections, and the symmetry of the abnormal ridges was in every respect complete."

MUSCULAR SYSTEM.

Diaphragm.—Bardeleben,[14] of Jena, calls attention to Hasse's work on the organs of motion, and particularly to a study of the movements of the diaphragm, as regards their influence on the abdominal organs. Every contraction of the diaphragm causes a dilatation of the heart during diastole, particularly of the right auricle. In this way the extent and rapidity of the contractions of the principal respiratory muscles are essential factors in the variations of pressure in the venous system. Further, every contraction of the diaphragm causes a flattening of the surface of the liver, and aids the circulation in this organ by the aspiration of venous blood into the cava and by suction of the portal blood into the liver. Each contraction further depresses and compresses the spleen, and thus the blood is pressed into the veins of the spleen. Lastly, contraction of the muscle exerts pressure on the stomach walls, promoting the discharge of its contents by the pylorus, besides aiding the evacuation of the gall-bladder.

In this connection the Editor would beg to repeat an opinion advanced by him some years ago[13] as to the diaphragm,—which he considers more as an appendage to the circulatory apparatus than as "essentially the chief agent in respiration," and for the following reasons:—

(1) The vena cava inferior opening, the highest point in the central tendon of the human diaphragm, holds a fixed relation to the right anterior inferior border of the ninth dorsal vertebra. (2) That portion of the central tendon embraced by the base of the fibrous pericardium is prevented from descending in inspiration by the superior tendinous crura of the diaphragm which are formed by the lateral parts of the fibrous pericardium ascending on either side in two planes to be attached to the apex of the bony thoracic cone and through the deep cervical fascia to the processes of the cervical vertebræ, and to each stylomaxillary ligament. (3) These superior tendinous crura of the diaphragm are connected by transverse and oblique fibrous bands, thus forming a fibrous scaffolding

for the support and protection of the heart and the great cardiac vessels. (4) The superior fibrous crura and the fibrous scaffolding between them are made tense and open for the lodgment and for the protection of the heart and its great vessels, and for the promotion of the circulation of the blood through them by the contraction of the muscular diaphragm, independent of the descent of its lateral wings, though in the descent of the lateral wings of the diaphragm the vertical area of the thorax is extended. (5) In the contraction of the muscular diaphragm its descent is not necessary, as it contracts on its own planes, which may be supported by the contraction of the stronger abdominal muscles.

The Palmar Fascia.—Grapow[15] concludes, after a careful study of the uses of the palmar fascia, that: (1) It secures the arching of the skeleton of the hand, and resists its flattening under pressure. (2) It has a hydraulic action, and by its alternate stretching and relaxation drives the venous blood and lymph toward the heart. (3) It renders the grasp of the hand surer by its intimate adhesion to the skin.

NERVOUS SYSTEM.

Palmar Nerves.—Hartmann,[16] at the December meeting of the Société Anatomique, drew the attention of the members to an undescribed though frequent disposition of the collateral branches of the palmar nerves, consisting of buttonhole anastamoses or elliptical loops, seldom longer than 10 mm. The simplest type is frequently seen in the terminal branches of the median, and in this locality one of the digital arteries may be observed passing through it, the object of the loop or "buttonhole" being doubtless to give passage to those special vessels. Generally but one or two are found, but in one case Hartmann met with three, giving passage to the first three digital arteries. He considers them by no means anomalies, having met with them in two-thirds of the subjects examined.

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PHYSIOLOGY.

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BLOOD.

One of the most revolutionary papers upon the structure and functions of the red corpuscles of the blood which has appeared in physiological literature for a long time has been published recently by Mosso[1] in the form of a preliminary communication, with the promise of a more complete paper with illustrations in the near future. Mosso calls special attention to the facility with which a large number of the red corpuscles undergo post-mortem changes after removal from their normal environments. It is not possible to make an ordinary microscopic preparation of blood without causing a large number of the red corpuscles to undergo alteration, or even complete destruction, changes which have in large part escaped the observation of previous investigators. Mosso gives the following description of the normal structure of a red corpuscle. Each corpuscle contains an external envelope or sac, a fibrillar reticulum, granular substance, and a nuclear sac. In the blood of birds the nuclear sac carries at the extremities of its long axis prolongations which place it in communication with the external envelope. Between the external envelope and the nuclear portion, in what Mosso calls the cortical part of the corpuscle, two substances are contained which mutually penetrate each other, one colored yellow by hæmoglobin, the other colorless. With the exception of the serum of the blood of the animal from which the specimen is taken, all so-called neutral liquids, such as normal salt solution, or fixing reagents, such as osmic acid, cause great changes in the red corpuscles, many of them disintegrating, so that the usual method of enumeration by diluting with an artificial serum cannot be considered of value as far as the absolute number of

corpuscles is concerned. The bi-concave form, which is universally believed to be the normal shape, Mosso takes to be the beginning of an alteration caused by abnormal conditions. In his opinion also the blood plaques must be considered as remnants of disintegrating red corpuscles. Not all of the red corpuscles can give rise to plaques,—only those which are so sensitive to changes in their surroundings. In opposition to all the present views of blood coagulation, Mosso holds that the red corpuscles play the chief part in the process. Their most characteristic degradation change is what he calls hyaline degeneration; a gelatinous transparent layer forms round the corpuscle, while the nucleus also becomes swollen, and usually these corpuscles fuse together into masses. He agrees with Bizzozero with regard to the part taken by the plaques in coagulation, though his interpretation of the phenomenon is different, inasmuch as he believes that the plaques are simply disintegrated red corpuscles. Mosso's theory of coagulation, then, is simple and entirely new. Briefly stated, he believes that the coagulum is composed of a certain number of red corpuscles which die, undergo hyaline degeneration, become decolorized, and form a gelatinous mass. He also thinks that the white corpuscles or leucocytes of the blood originate from the red corpuscles. In normal blood he distinguishes four kinds of leucocytes, namely, those with fine granules, those with large granules, nuclear sacs, and hyaline corpuscles. The finely granular leucocytes originate from the nuclei of the red corpuscles. The leucocytes with large granules are also derived from the red corpuscles. They can often be found in intermediate stages with few granules and still colored with hæmoglobin. The amœboid movements of these corpuscles, so universally regarded as the expression of an actively living cell, are in Mosso's opinion simply an indication of death and disintegration. The presence of so many leucocytes in the lymph circulation offers no difficulty to his theory, since he believes that the red corpuscles easily migrate through capillary walls, and get into the lymph spaces. Here the weaker ones undergo degenerative changes and form leucocytes, while the more resistant ones are finally brought back to the blood unharmed. With regard to the origin of pus, he criticises Cohnheim's experiments upon the migration of the white corpuscles from the blood-vessels during inflammation. He states that in repeating Cohnheim's experi-

ments he found that the migration of white corpuscles is a comparatively rare phenomenon, and in this respect Mosso is in accord with several other observers.

On the contrary Mosso states that the red corpuscles easily penetrate the capillary walls, and the less resistant ones change to leucocytes. Only on such a theory, he contends, is it possible to explain the enormous numbers of pus corpuscles found in abscesses. Microscopical examination of pus shows the red corpuscles in various stages of transition to pus leucocytes, and their transformation can be seen more satisfactorily when a drop of human blood is injected into the anterior chamber of the eye of the dog; the drop of blood under these conditions soon changes to pus, and the transitional changes can be obtained without difficulty. Moreover, the malarial germ of Laveran and the cells found in various tissues of the body, which have been described as giant cells, osteoclasts, etc., he also explains as originating from the degeneration of red corpuscles. As the communication is only preliminary and unaccompanied by figures, it is impossible to criticise it justly; but judged from internal evidence it is an unsatisfactory paper, and the novel theories which the author proposes are too much opposed to many well established facts to meet with any acceptance unless supported by very strong evidence. For such evidence we must wait until the complete paper appears.

The chemistry of the coagulation of blood has also received an entirely new contribution during the present year from Wooldridge.[2] The theory now most generally accepted is the modification of Schmidt's old theory, suggested by Hammarstem.

According to the latter the formation of fibrin results from the splitting up of fibrinogen under the influence of fibrin ferment, paraglobulin not entering into the reaction, but acting only as a favoring condition. For the past few years Wooldridge has been working out a new theory, the latest form of which is published in the paper under consideration. It is his opinion that the corpuscles of the blood have nothing at all to do with the process of clotting. Coagulation is dependent upon the reciprocal action of two substances contained in the blood-plasma, to which he gives the names of A-fibrinogen and B-fibrinogen. These fibrinogens are combinations of albumin and lecithin. In blood-plasma prevented from clotting by addition of peptone solution, A-fibrinogen

can be separated by cooling to 0° C., in the form of minute rounded granules, which again dissolve in the plasma when the temperature is raised, or may be dissolved by the action of dilute saline solutions like the other members of the globulin group of albumins. This A-fibrinogen in solution is not affected by the action of fibrin ferment. It is well known that peptonized plasma may be made to coagulate by diluting with water or by passing CO_2 through it. According to Wooldridge, this is owing to the presence of A-fibrinogen, since if this albumin is removed the peptonized plasma will no longer clot when acted upon by either of these re-agents. Plasma from which the A-fibrinogen has been removed still contains large quantities of B-fibrinogen. Although a plasma containing only this latter fibrinogen will not clot upon the addition of fibrin ferment, or even blood serum, nevertheless from it by partial precipitations with NaCl, the fibrinogen of Hammarsten can be obtained, solutions of which in dilute saline will clot upon the addition of ferment or serum. According to his view, then, the fibrinogen obtained by Hammarsten does not pre-exist in normal plasma, but is a product of the transformation of B-fibrinogen, which is one of the elements of normal blood. Coagulation consists in an interaction between the A- and B-fibrinogens in which the A-fibrinogen loses some of its lecithin, which is taken up by the B-fibrinogen, the latter then changing to fibrin. Instead of A-fibrinogen any lecithin containing compound—that, for instance, which may be extracted from the brain or the testis—is equally effective in causing the transformation of B-fibrinogen to fibrin. We know perfectly well that normal plasma can be prevented from clotting by cooling to near 0° C., or by salting with magnesium sulphate. Both these actions are explained by Wooldridge upon the supposition that the A-fibrinogen is thereby precipitated. But it is further known that in salted plasma, even when filtered so as to get rid of this precipitate of A-fibrinogen, coagulation is caused by the simple addition of a ferment. According to the theory, the B-fibrinogen is unaffected by ferment alone, and to explain this case Wooldridge is obliged to assume that the B-fibrinogen left in the plasma after filtering, undergoes in some way a transformation to the ordinary fibrinogen of Hammarsten. It is scarcely possible to criticise the work of Wooldridge, since he seems to have had no followers in his peculiar

methods of experimenting upon the blood, and his statements therefore have not been tested by independent observations. His theory, however, is not an attractive one, and the experiments in support of it are far from conclusive. Without more convincing proofs, it is not possible for one who has worked at the subject to admit that the fibrinogen obtained from blood-plasma by the method of Hammarsten is not normally contained in the blood.

The action of peptone in preventing the coagulation of blood, first noticed by Schmidt-Mulheim, has been the subject of investigation by Campbell.[3] Peptone injected into dog's blood in the proportion of 0.3 grams of peptone to each kilogram of body weight, will completely prevent coagulation in the blood drawn shortly afterward. Fano found that the blood of rabbits is not affected by such injection, and Campbell states that the same is true of cats. The blood after being drawn from the body, in the case of the dog and also the terrapin, may be prevented from coagulation by the direct addition of peptone solution, though a greater quantity is necessary than when it was injected at once into the circulation of the living animal. In order to understand how the peptone acts in preventing coagulation, Campbell tried the effect of adding it directly to a solution containing only pure fibrinogen and fibrin ferment. Such a solution, without the addition of peptone, clots readily, but when peptone is added, coagulation is either slowed or stopped altogether, depending upon the proportion of peptone used. This experiment shows that peptone will prevent the interaction of fibrin ferment and fibrinogen; but it does not explain altogether the action of peptone injected into the circulation of the living animal, since a smaller quantity is necessary in this case than when peptone is added to blood drawn from the animal and in which the ferment has had time to form. The efficiency of the smaller amount in the first place depends, according to Campbell, upon the fact that some of the elements of the blood, probably the leucocytes, take up a portion of it, and in this act are so changed as to be incapable of taking part in coagulation. The author seems to think that the action of peptone in preventing coagulation is twofold: First, by its action on the leucocytes it prevents the formation of ferment; second, when the ferment is formed, the presence of peptone prevents or retards the action of the ferment in changing the fibrinogen to fibrin.

The origin of the ferment in shed blood which starts the process of coagulation is still unsettled. It has been shown in the last few years that what we call fibrin ferment may be formed in the disintegration of almost any form of albumin. While this must be accepted as true, it still remains a question as to what body gives rise to the ferment in shed blood. There are at present two views. According to the older one, the breaking down of the white corpuscles of the blood liberates the ferment; according to the more recent theory, the disintegration of the blood plaques is the origin of the ferment. Krüger,[4] in a recent paper, endeavors to prove the old theory. Contrary to the results of Wooldridge, he finds that the injection of leucocytes into the blood of a living animal quickly causes death from intravascular clotting. This happened when the leucocytes were obtained from lymph glands as well as when obtained from settled horse blood. This he takes as demonstrating the incorrectness of the theory of coagulation proposed by Wooldridge, according to which the corpuscular elements of the blood take no part in the process. The experiments of Krüger, while showing that injection of leucocytes into the blood in large quantities will cause intravascular clotting, are by no means proof that the normal clotting of blood starts from the breaking down of the leucocytes. The balance of evidence at present points to the plaques as being the source of the ferment. Whether or not they are to be considered as independent elements of the blood, is another thing. According to some they are simply derivatives of the breaking down of the red or white corpuscles. A new theory of their origin is proposed in a paper by Löwit.[5] The plaques of warm blooded animals he regards as simply globulins precipitated from the plasma and accidentally assuming the shape of formed elements. From observations made upon the mesentery of living white mice, he states that these bodies are not normally present in the blood.

It may be mentioned that Eberth,[6] in a new paper, publishes a description of the histology of certain corpuscles in the cold blooded animals, which correspond in function to the plaques of mammals. These corpuscles are oval, or in some cases spindle shaped bodies, containing a very large nucleus surrounded by a small envelope of protoplasm. Like the plaques of mammalian blood, they quickly run together into masses after the blood is

drawn, a property not shown by the leucocytes, from which they are quite distinct morphologically.

To the other constant chemical constituents of the blood, it seems that we must now add lactic acid. Berlinerblau,[7] from analyses of the blood of several animals, obtained the following results. Rabbit blood contains from 0.0645 to 0.0723 per cent. of lactic acid; dog's blood, 0.071 per cent., and venous human blood 0.0079 per cent. Artificial circulation of blood containing glycogen through the hind limbs of dogs and rabbits, caused a marked increase in the percentage of lactic acid in the blood used. Since the perfused blood contained always in addition a certain amount of sugar not present in it before, the theory is that the glycogen was first changed to sugar and then to lactic acid. Experiments of Seegen pointing in the same direction, will be mentioned in speaking of the chemistry of muscle.

Some interesting experiments have been made by Jones[8] to determine the variations in the specific gravity of the blood during health, and the causes producing these variations. While not of direct practical or theoretical importance, they give statistics which may prove useful.

His experiments were all made upon human blood, a drop of blood being taken from the finger near the nail. The method of determining the specific gravity of this drop was a variation of that originally proposed by Roy. The drop was introduced into a mixture of glycerine and water of known specific gravity, and a number of different solutions having been prepared previously, the solution in which the drop of blood just floated gave its specific gravity. The results obtained were as follow:—

1. *Effect of Age and Sex.*—The specific gravity of the blood is highest at birth, about 1,066 in both sexes, and falls rapidly up to the second year, the fall being especially sharp about the second week of extra-uterine life. At the end of the second year it varies from 1,048 to 1,050, and then begins to rise again, the curve of increase being distinctly different in the two sexes. The male and female probably never have blood of the same specific gravity except shortly after birth and in old age. During pregnancy the specific gravity of the female blood is always slightly lower than in women of the same age who are not pregnant.

2. *Effect of Food.*—Eating always tended to produce a lower-

ing of the specific gravity, which was more marked the greater the quantity of water taken with the food. When alcohol was used with the food, this fall was not noticed.

3. *Diurnal Variations.*—There is a well marked diurnal variation. The specific gravity falls steadily during the day with more sudden drops after each meal; while during the night, when sleeping, it slowly rises again. In like manner, constant differences were found in blood taken from various parts of the body. Jones attempts no general explanation of the cause of these changes; but it is very interesting to notice, that, as far as the data in our possession go, in nearly all the cases where Jones found a diminution in the specific gravity of the blood, other observers have shown there is a corresponding diminution in the number of red corpuscles, and vice versa. The coincidence seems to show that the two series of facts stand in close connection, and that possibly the low specific gravity in any particular case is an indication of a less number of red corpuscles, or that both diminution in the number of red corpuscles and in the specific gravity simply means a greater relative amount of plasma at such times.

MUSCLE.

Ewald[9] has attempted to obtain a final answer to the question as to whether the volume of the muscle changes during contraction. It is agreed on all hands that the change if any, is very slight. It is generally stated that the volume is diminished by an amount equal to 1-1370. Ewald has devised new and more delicate apparatus to investigate this point, and has also repeated the experiments of other observers, using their apparatus. He states that in no case could he get any change at all in volume. He further says that in repeating the experiments of others on this subject, he has been able in each case to detect the probable error, always an error in apparatus, and has thus reconciled the differences in their results. His experiments seem to prove that the muscle undergoes no change of volume at all during contraction.

Marshall[10] brings forward a new theory of muscle contraction founded upon recent discoveries in the histology of the muscle fibre. Melland some time ago published in the same journal an account of the microscopic structure of the muscle fibre, which is fully corroborated by Marshall, and agrees with recent work by Retzius

and others. According to these observers, the muscle fibre is formed essentially of a reticulum containing within its meshes the main bulk of the fibre, the sarcous substance. The reticulum consists of longitudinal bars running the whole length of the fibre, and corresponding to the muscle rods of Schaefer. At certain points in the fibre corresponding to the position of Krause's membranes, that is, in the middle of each light band, these longitudinal bars are interrupted by a transverse net-work of fibrils. The usual appearance of a muscle fibre, that of alternating dim and light bands, is, according to this view, simply an optical phenomenon caused by the refraction of light at the nodal points where the longitudinal and transverse fibrils meet. Marshall's theory of the muscle contraction is that it is caused by a shortening of the longitudinal bars, these being the only contractile substances in the fibre The function of the transverse fibrils is to bring the fibre back to its normal resting shape, after the contraction is over, by virtue of their elastic action. Marshall finds that wherever in the animal kingdom muscles are present which can contract quickly, this reticulum of longitudinal and transverse fibrils in the muscle fibre can be demonstrated; while muscles which contract slowly, like the ordinary involuntary muscle of mammals, are provided only with the longitudinal fibrils. The most important part of the contribution is the description of the histology of the fibre. The explanation of the striated appearance of the voluntary muscle fibre given by Melland and Marshall is somewhat supported by a recent contribution of Exner,[11] in which the optical properties of the living muscle fibre are critically examined. His paper calls attention to the fact that the numerous layers which have been described by different observers may be simply the optical effects of the interference of light waves, and cannot be accepted as representing actual structures. He believes that the typical muscle fibre consists of two layers, a dim and a light band alternating with each other, and that this appearance also is at bottom an optical effect, whatever the structural difference may be which gives rise to it.

A re-investigation of the effect of warming upon the irritability of frog's muscle by Edwards[12] has led to some interesting and suggestive results. The experiments were made upon curarized and non-curarized muscles, upon muscles excised from the body, and upon muscles left in the body with the circulation intact. The

muscles were enclosed in a double walled chamber, the temperature of which could be easily regulated by water flowing between the walls. Edwards found that the effects of warming fall into four stages or periods. First, as the muscle is warmed from the temperatnre of the ordinary room, there is a gradual increase of irritability up to a maximum, the contractions with the same strength of stimulus becoming higher and higher until the maximum is reached. The temperature of this maximum irritability varies from 32.75° C. to 39.25° C. Second, as the temperature is raised above the point of maximum irritability, there is a gradual diminution of irritability up to complete loss. This effect was obtained by keeping the temperature constant at the point of maximum irritability for a long time, or more quickly by allowing the temperature to rise slightly. In this stage the height of the contractions, with a stimulus of constant strength, gradually sinks to zero. The third stage is a condition of complete loss of irritability. By carefully regulating the temperature the muscle can be kept in a condition in which it does not respond to a maximal stimulus from an induction coil, but yet does not enter the stage of heat rigor. The muscle can be kept in this condition of apparent death for half an hour, and then by careful cooling will regain almost its original condition, and can be used for a second similar series of heating experiments. The fourth stage is that of the development of heat rigor. If heated slightly above the temperature necessary to keep it in stage three, the muscle begins to shorten from the onset of rigor. If kept at a constant temperature, the time necessary for the development of complete rigor varies from thirty-five minutes to one hour and twenty-eight minutes, though a much less time is necessary if the temperature is allowed to rise. The most interesting result of the paper is the fact that when heated to a certain temperature, the irritability of the muscle can be destroyed without causing heat rigor, and that the muscle can be kept in this condition for a long time and its irritability be restored by subsequent cooling. In other words, by heating, the muscle can be brought into a condition similar to that caused by lowering the temperature to a certain point; and this fact, when more fully worked out, may aid in explaining the summer dormancy of animals, and the connection between it and the more usual winter dormancy or hibernation. Von Frey[13] contributes some inter-

esting facts with regard to the effect of different loads upon the contraction of muscles. In all his experiments the gastrocnemius muscle of curarized frogs was used. Using single maximal stimuli, he found, as he had previously observed for tetanic stimuli, that the height of the contraction increased with the load, at least with the two weights used, namely, 0.5 gram, and 10.5 grams. One most interesting result obtained was that with an unloaded muscle, or what practically amounted to an unloaded muscle, a muscle with only a weight of 0.5 gram, the single contractions with maximal stimuli were as great as the tetanic contractions. Under these conditions, therefore, there is nothing of what is usually called a summation of contractions. With a muscle loaded with 10.5 grams, on the other hand, such a summation does occur, the tetanus curve is higher than that of the simple contraction. In the same way it was found that when the first stimulus causes the muscle to pass into a state of contractur a summation is also obtained, the second contraction starting from the height of the contractur.

Lee[14] describes the electrical phenomena accompanying the contractions of different muscles of the frog, making use of the capillary electrometer instead of the galvanometer to determine the changes in electrical condition. He finds that in most of the muscles of the frog, when the muscle is stimulated through its nerve, and the wires to the electrometer are led off, one from the middle, and one from the lower end of the muscle, the curve of variation in the electrometer shows three phases: first, a decided but brief negative variation; second, a longer lasting positive variation; and third, a long continued negative variation lasting through the time of contraction and relaxation of the muscle. From the long duration of these electrical phenomena, extending over the whole period of the muscle contraction, Lee concludes that there is a much closer connection between the electrical changes and the mechanical changes in form of the muscle than is usually supposed. The electrical phenomena have been considered generally as preceding the mechanical phenomena of the shortening of the muscle; that is, as an indication of the chemical or physical changes in the muscle substance which are preparatory to a contraction. Lee's experiments show that the two sets of phenomena—electrical and mechanical—run a parallel course as far as the element of time is concerned, and furthermore, in a fatigued

muscle, both the mechanical and electrical curves are prolonged and lowered.

A number of experiments have been made by Fick[15] on muscular contractions in living men. With voluntary stimuli the lifting power of the muscle used, the abductor indicis, was found to be 2 kilos., or, calculating for leverage, 10 kilos. This represents nearly the absolute power of the muscle, not exactly, because the direction of the fibres was not considered. A remarkable fact obtained was that the power in tetanus was ten times what it was with single shocks, while in the contractions of the frog's muscle, the ratio was only as one to two. It would seem then, that in the human muscle the summation of contractions is more complete than in frog's muscle. Electrical stimulation, Fick found, does not bring out the power of the muscle to the same extent as voluntary stimulation.

With regard to the chemistry of the muscle, the most important contribution of the year is a paper by Halliburton.[16] The author states that the well known experiments of Kühne upon the muscle plasma and its coagulation, made upon the frog's muscle, can be repeated easily upon the muscle of warm blooded animals. His method of working was as follows: a rabbit was bled to death from the carotid, the abdomen was quickly opened, a cannula inserted into the descending aorta, and normal salt solution cooled to 5° C. was injected until the vessels of the lower limbs were distended. The inferior cava was then opened, and the injection continued until every trace of blood was washed out. Next the limbs were quickly skinned, small pieces of muscle rapidly cut out, and thrown into a mixture of ice and salt. After they were frozen hard they were removed to a cold plate, and cut into fine slices across the direction of the fibres with a knife previously cooled. The frozen slices were then wrapped in linen, and the plasma pressed out by means of a metal lemon-squeezer also previously cooled. The muscle plasma obtained in this way was a yellowish viscid liquid, faintly alkaline, and at ordinary temperatures clotted in from one to two hours, though if kept at 40° C. coagulation occurred within thirty minutes. Curiously enough this plasma takes a longer time to clot than the muscle plasma of the frog. Following the analogy of blood coagulation, Halliburton found that by making extracts of the frozen muscle with a ten per cent.

NaCl solution, five per cent. $MgSO_4$ solution, or a half saturated solution of Na_2SO_4 he could get what we may call a salted muscle plasma, which, like salted blood plasma, did not clot except when diluted, and then gave a typical muscle coagulation with formation of myosin. Moreover, if the animal was allowed to go into complete rigor mortis, and the coagulated myosin of the muscle was extracted by any of the above mentioned saline solutions, then the solution of myosin when diluted clotted just as the solution of fresh frozen muscle plasma, the only difference in the two solutions being that the extract of the dead muscle had an acid reaction, while the muscle plasma itself had an alkaline reaction. One of the most curious results obtained by Halliburton was that, after extracting the myosin of muscle with NaCl or $MgSO_4$, and then diluting the solution so as to make it clot, this clot could be redissolved in either of these saline solutions, and the solution when diluted again clotted. This clot in turn could be treated the same way, the process being repeated five times in one specimen. Calling the precursor of myosin in the muscle plasma myosinogen, the passage of a living muscle into rigor mortis may be explained as a transformation of myosinogen to myosin, and the passing away of rigor as a transformation of myosin back to myosinogen, since the clot of myosin when dissolved in saline solution evidently passes back to myosinogen. When the salted muscle plasma or the saline extract of dead muscle was heated by the method of fractional heating, it showed the presence of four proteids, with the following temperatures of heat coagulation: 47° C., 56° C., 63° C., 73° C. The muscle serum left after the separation of the clot of myosin contained two albumins, coagulating at 63° C. and 73° C., while the myosin clot, when redissolved in salines, was found to contain the two albumins coagulating at 47° C. and 56° C.; so that what is called myosinogen really consists of these last two albumins, and in coagulating they are either transformed directly into myosin or unite to form the myosin, in this respect differing from blood coagulation.

In all his experiments, whenever myosin was formed, an acid reaction was developed at the same time in the liquid, giving some additional proof of the generally accepted view that the acid (lactic) developed when a muscle passes into rigor comes from the proteid constituents, and not from a transformation of glycogen. On the

other hand a number of independent investigations made during the course of the present year unite in showing that muscle is capable of transforming glycogen to lactic acid, whether or not the glycogen is the direct source of the acid formed during contraction and rigor mortis. Carrying out still further the analogy with blood coagulation, Halliburton treated dead muscle with alcohol according to the method used by Schmidt for extracting fibrin ferment from serum. He obtained a solution which had a decided effect in hastening myosin coagulation, containing therefore what he calls myosin ferment. It was not precipitated by boiling, but gave the proteid reactions, and when concentrated answered to the biuret test. Examination of this solution convinced him that the proteid present was an albumose. When the solution was saturated with ammonium sulphate all the albumose was precipitated. The liquid remaining had no ferment action, while the precipitate, when redissolved, gave distinct indication of the presence of ferment like the original solution. From this he concluded that the albumose acts as a myosin ferment. The action of this myosin ferment was not destroyed by heating until the temperature reached 100° C., in this respect differing from fibrin ferment. Further experiments showed that the fibrin ferment and the myosin ferment were not interchangeable. Halliburton's experiments are particularly welcome because of the light they throw on the nature of the different albumins in muscle plasma. The temperature of the heat coagulation of these albumins has already been given. The names which he proposes for them are as follow: The albumin coagulating at 47° C. he calls paramyosinogen; it takes part in the formation of myosin though it will not alone give a clot of myosin when acted upon by myosin ferment. The albumin coagulating at 56° C. he names myosinogen; it takes an essential part in the formation of the myosin clot, and when isolated and treated with myosin ferment, it will itself form a clot. The albumin coagulating at 63° C. he names myoglobulin; it resembles paraglobulin very closely in its properties, except that it coagulates at a lower temperature; it takes no part in the formation of the clot. The albumin coagulating at 73° C. he names muscle albumin; it is apparently identical with the serum albumin of blood, and with the serum albumin of muscle serum previously described by Kühne. The albumose found in the muscle serum he believes to be the

same as the deutero-albumose of Kühne and Chittenden, and moreover it acts as a myosin ferment. In connection with Halliburton's paper, and having a possible connection with some of his results, may be mentioned a communication by Brown-Séquard,[17] who, in 1885, pointed out a curious phenomenon shown by dead muscle which had passed into rigor mortis. He found that muscles in this condition were not absolutely quiescent, but contracted and relaxed periodically as in living muscle, except that the contractions and relaxations were not so marked and were of much longer duration. He has since studied the phenomenon with more care and taken graphic records of the movements. He finds that the contractions are quite regular, indeed, almost rhythmic in character. On the two sides of the body the movements showed great similarity, and they might continue for weeks after the death of the animal. In muscles paralyzed by section of the sciatic nerve in a living animal, movements of this kind were not observed, which seems to show that the death of the muscle and the development of rigor were necessary conditions for their existence. With regard to the cause of these movements, Brown-Séquard promises another communication in which he intends to demonstrate that they depend upon the independent irritability of the muscle. It seems quite possible that these post-mortem shortenings and lengthenings of the muscle may be owing to the partial solution and recoagulation of the muscle myosin, as suggested by the experiments of Halliburton just quoted.

From chemical analyses of the fresh muscle of the dog and the horse, Seegen[18] is able to confirm the statement of Nasse that glycogen is a constant constituent of fresh muscle, and that the longer the muscle is kept the more of the glycogen disappears, sugar taking its place. Since the conversion of the glycogen to sugar continued long after rigor mortis had set in, Seegen concluded that the muscle itself possesses the inherent power of producing this transformation. To determine the influence of muscular tissue upon this reaction, he mixed together a solution of glycogen of known strength, blood, and pieces of fresh muscle. The blood was kept arterialized by air drawn through it, and was used with the idea that it would keep the muscle in a living condition. When these three things were kept in contact with one another for several hours, it was found that the glycogen had

completely disappeared, and a corresponding amount of sugar had appeared. The conversion of the glycogen in this case was caused partly by the blood, as shown by control experiments, but chiefly by the muscle. He concluded from this that muscle kept living (?) by contact with arterial blood is capable of changing glycogen to sugar. These experiments cannot be taken as applicable at once, without further proof to living muscle under normal conditions. The experiments of Berlinerblau, previously quoted, gave similar results, but were made under much better conditions. The latter showed that when glycogen was added to blood kept circulating artificially through the hind limbs of dogs and rabbits, the lactic acid present in the blood was markedly increased, and that sugar also appeared in the blood; apparently the glycogen was changed first to sugar, and this in some way was converted into lactic acid. Somewhat similar experiments by Marcuse[19] gave practically the same results. The author concluded that the glycogen in muscle is the source of the lactic acid formed during contraction, whatever may be the source of the acid produced when the muscle goes into rigor.

Chauveau and Kaufmann[20] in a very ingenious way have attempted to show that the amount of energy consumed in the mechanical work of a contracting muscle will appear as heat if the contraction of the muscle is prevented from performing mechanical work. Their experiments were made upon the levator muscle of the upper lip of the horse. They found that when this muscle contracted without doing work, the heat production for each minute and gram of muscle was 0.000323 cal.; while when the contraction was allowed to perform work, the heat production was 0.000289 cal. So that the heat equivalent of the work done was 0.000034 cal. in this particular experiment. In a second series of experiments, the work performed by this muscle when in normal physiological activity, that is during the process of eating, was determined by a specially constructed dynomometer. Calculating for one gram and one minute of time, it was found to be about 13 to 15 gram metres; and this, reduced to its heat equivalent, equals 0.000031 to 0.000035 cal.,—figures which agree very well with those given above as the excess of heat produced in the muscle when contracting without performance of work. The value of the experiments consists in showing that the portion

of energy which usually appears as work is liberated in the form of heat when the muscle is so situated that no work can be done.

PERIPHERAL NERVES.

The troublesome subject of trophic nerves has received a contribution from Joseph.[21] In his experiments the second spinal nerve was chosen on account of its very favorable position for operating. The ganglion of this nerve, together with portions of the anterior and posterior roots, was excised in young kittens, and the invariable result was that the hairs upon certain areas of the head, chiefly in a region lying posterior to the ear and between it and the skull, atrophied and dropped out, leaving bald places. In this case it was not possible to explain the disturbances of nutrition in these areas upon the usual grounds of changes in the circulation, or mechanical injury resulting from a loss of sensibility in the parts affected. Gaskell's recent work has shown that no vaso-motor fibres leave the spinal cord through this nerve, and Joseph could find no evidence of any vaso-motor changes after the section of the nerve, while the position of the bald spots were such as to protect them from injury. The experiments appear to give some satisfactory evidence for the theory of trophic nerves. For the existence of such nerves, a considerable amount of evidence has been accumulating within recent years as the result of purely physiological experiments,—for instance, Gaskell's work upon the action of the vagus upon the nutritive condition of the heart. The evidence from the side of pathology is not always so direct, owing to the unavoidable presence of disturbing conditions which usually make it impossible to refer the effects of pathological lesions directly to the action of trophic nerves. It is interesting in this connection to notice that several observers have furnished histological proof of the connection of nerve fibres with tissue elements which are neither motor, sensory nor glandular. Quite recently Hoffmann[22] has published an account of the connection of nerve fibres with the connective tissue cells of the mesentery and the germinating cells surrounding the stomata of the peritoneum.

One of the most interesting questions in nerve physiology is that of the direction in which degeneration takes place when the nerve is cut. The general view is derived from Waller's experiments. According to Waller, when a nerve trunk is cut, all the

peripheral portion degenerates completely, while the central portion remains intact. This difference is explained by supposing that the nerve cells with which the central end of the nerve is connected act as trophic centres, while the peripheral end dies because it is cut off from its connection with these centres. This apparently satisfactory theory is found not to meet the facts in the case. It has been shown in a number of experiments that the central end of the nerve, at least, does not follow the Wallerian law; it does not remain entirely unaffected after section of the nerve. Experiments of the present year by Friedländer and Krause and by Krause[23] are valuable in this connection, since they were made chiefly upon man. The observations were made upon amputated limbs. In Krause's work the nerves were got quite fresh for study from the amputation of limbs attacked by gangrene. The destruction of the peripheral portion of the nerve by gangrene is presumably equivalent to destruction of the nerve by section or other means. Since the amputation was made some distance above the point diseased, it was possible to study the effect of this pathological section upon the central end of the nerve. Krause found, in corroboration of his and Friedländer's study of the central end of the nerve upon the cadavers of persons whose limbs had been amputated some years previously, that in the central end a number of fibres had degenerated. These were supposed to be sensory fibres coming from the peripheral regions to which they were formerly distributed. The study of the peripheral stump of the cut nerve was not possible, of course, in man, so that for this side of the question recourse was had to rabbits. Contrary to the usual view it was found that in the peripheral stump a number of fibres did not degenerate, though most of them did. Krause states that in the rabbit as many fibres in the peripheral end of the cut nerve remained normal as suffered degeneration in the central end. By inference he supposes the same to be true for man. Assuming the correctness of the Wallerian theory, that nerves die after separation from their trophic centres, it would follow that the nerves in question, which do not degenerate in the peripheral end and do degenerate in the central end, must have their trophic centres in the peripheral tissues. Such fibres in a rabbit are few in number and may possibly be explained as recurrent sensory fibres, but in man, if the inference Krause makes is allowable, they are much

too numerous to be explained in this way. Krause supposes that they are fibres which are in connection at the periphery with special sense organs, possibly the touch corpuscles of Meissner, which act as nutritive centres.

Bowditch[24] contributes some interesting results obtained by himself and his pupils with regard to the action of ether upon peripheral nerves. If the sciatic nerve of a frog was stimulated by an induction shock of ordinary strength the usual result was extension of the leg and abduction of the toes. When, however, the leg was suspended in a dilute (three per cent.) solution of ether, after some time stimulation of the same strength might cause exactly opposite movements, namely, flexion of the leg and adduction of the toes. This ether effect after a longer time passed into complete paralysis, stimulation of the sciatic causing no contractions at all. If the leg was removed from the ether solution and washed in normal salt solution, the paralysis passed off, and during the recovery stimulation of the sciatic again gave the ether effect, while after complete recovery stimulation gave only the usual extension and abduction. When a loop of the nerve was immersed directly in the ether solution, substantially the same results were obtained. Bowditch explains the phenomenon in this way: "The ether seemed to produce a change in the nerve at the point of application which rendered it incapable of transmitting the ordinary nerve impulse, complete paralysis resulting when the action of the drug was pushed to its extreme, and the so-called ether effects during intermediate stages." What this "ether effect" really is, was seemingly explained by further experiments upon the effect of weak and strong stimulation of the uninjured sciatic nerve of the frog. By employing very weak induction currents to stimulate the sciatic, flexion and adduction, the ether effect, was frequently obtained, while stronger stimulation gave the usual extension and abduction. Moreover, after the nerve had been submitted to the action of ether, and the ether effect had been obtained with a certain strength of stimulus, simply increasing the strength of the stimulus was sufficient to cause extension and abduction. It seems clear, then, that the ether effect can be explained best by "supposing that a partial paralysis of the nerve by the drug converts what would naturally be a strong into a weak irritation, and that this weak irritation affects only the flexor group of muscles, because

these are for some reason or other more irritable than their antagonists." A more interesting example of this same ether effect is found in the action of the recurrent laryngeal nerve of the dog upon the abductors and adductors of the larynx. The first record of this was made by Hooper in 1885. He found that while ordinary stimulation of the recurrent laryngeal of the dog, when slightly or not at all anæsthetized, always caused a constriction of the glottis, when the animal was deeply narcotized with ether the same stimulation caused a dilatation of the glottis. This has since been corroborated by experiments of Semon and Horsley. F. Donaldson, Jr.,[25] in a paper recently published, has shown that here also the ether effect can be explained by supposing that a partial paralysis of the nerve by the drug converts what would naturally be a strong into a weak irritation. Donaldson found that weak stimulation caused abduction only, and that this passed into adduction as the strength of the stimulus was increased. His results were obtained upon animals when slightly or deeply anæsthetized (stronger stimulation being required in the latter case to produce the adduction), and in animals in which no drug at all was used. In the latter case the medulla was destroyed, and the operation of exposing the nerve was quickly performed before the irritability of the nerve and the laryngeal muscles had disappeared.

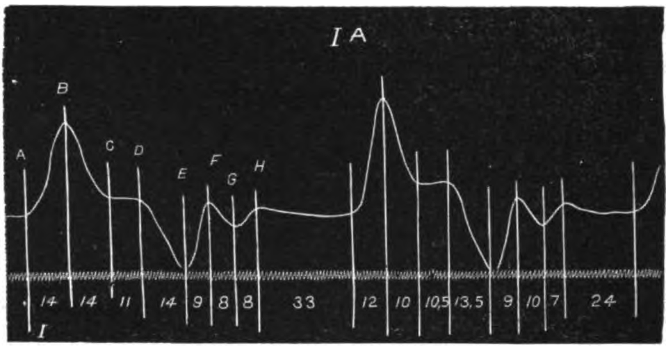
The results of section of the cervical sympathetic in mammals has been known since Bernard's famous experiment on rabbits. Pye-Smith[26] has found that the effects of this section are permanent. In rabbits kept for years they could still be observed. This result may be considered as an argument against the theory of peripheral ganglionic centres in the parts affected, since otherwise a recovery of vascular tone should have been expected. An interesting side result was that after division of all the nerves going to the ear, causing complete loss of sensibility and permanent congestion, the tissues continued to be properly nourished, and sores when produced healed readily, indicating the absence of any special trophic nerves.

Gaskell,[27] working by his new method of histological examination, has proved to his own satisfaction that the nervi erigentes, like the vaso-constrictor nerves, leave the cord in the anterior spinal roots. Besides the morphological evidence, he found that

stimulation of the anterior roots of these spinal nerves caused erection almost as pronounced as when the nervi erigentes themselves were directly excited, while stimulation of the posterior roots had no effect. As far as experiments have been made, the indications are that all efferent nerve fibres, and not the motor fibres alone, leave the spinal cord through the anterior roots.

CIRCULATION.

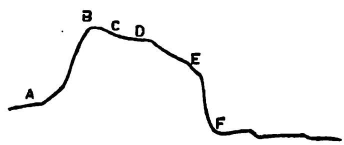
The phases of the heart beat, as shown in the cardiogram of the apex beat of the human heart, has been given a new interpretation by Martius,[28] who obtained his curves by means of the polygraphion of Grunmach. By comparison of the curves obtained from the polygraphion with auscultation of the heart sounds, and tracings of the carotid pulse he was led to the following explanation of the cardiogram shown in the accompanying figure.



CARDIOGRAPHIC CURVE FROM MARTIUS.—(*Zeitschrift f. Klinische Medicin.*)

The beginning of the systolic rise, marked A in the figure, coincides with the first heart sound and the firm closure of the auriculo-ventricular valves. The semilunar valves are not forced open at the same instant. On the contrary, during the whole rise of the curve, both the auriculo-ventricular and semilunar valves are closed, and the contracting ventricle is simply squeezing on its contents. It is during this period that the tense heart pushes out the integument, and makes the cardiac impulse. The apex of the curve or the beginning of the fall of the lever marks the time of the opening of the semilunar valves (B of the figure); that is, the time at which the pressure within the ventricle has overcome the arterial pressure and thrown the valves open. During the whole

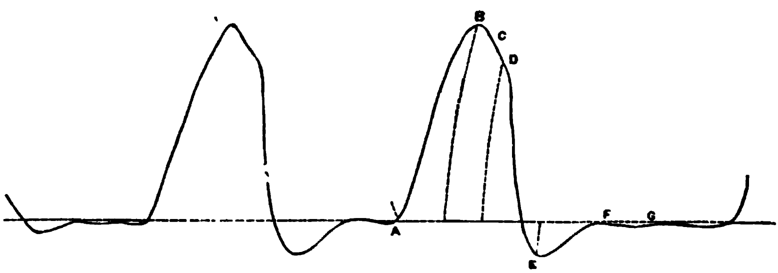
of the period of the descent of the lever, from B to C, the blood is streaming from the left ventricle into the aorta. The closure of the semilunar valves occurs at C, and indicates the beginning of the diastole. This last point was determined by auscultating the heart, the point indicated being coincident with the second sound of the heart. Martius' statement that the apex of the curve marks the opening of the semilunar valves differs somewhat from previous views. His evidence for this statement is as follows: he determined the rate of propagation of the pulse, and calculated what time would be necessary for it to travel from the heart to a given point of the carotid; this time, in one experiment, he found to be 0.03 of a second. He then took simultaneous tracings of the heart and of the carotid pulse. The curves showed that the rise of the carotid pulse began just 0.03 of a second after the apex of the cardiogram curve, demonstrating that the apex of the latter curve marked the opening of the semilunar valves. An almost exactly similar series of experiments by Edgren[29] gave results in some respects different and in some respects the same. An example of the cardiographic curve obtained by him is given in the accompanying figure. Edgren used the transmission method of Marey (system of tambours) to register the heart beats. He interprets his curve in this way: A marks the beginning of the systole, as it falls in with the time of the first heart sound, B the opening of the semilunar valves, determined by the same method as that used by Martius. So far the two observers agree exactly. E marks the beginning of the diastole and F the closure of the semilunar valves, the latter falling in with the second heart sound; in these points Edgren differs from Martius, and agrees with Chauveau and Marey. By comparisón of the curve with pulse tracings from the carotid, and making allowance for the time of transmission of the pulse wave, he found that the closure of the semilunar valves was coincident with the dicrotic wave of the pulse, indicating, therefore, that this latter is probably a reflected wave due to the sudden closure of the valves.



CARDIOGRAPHIC CURVE FROM EDGREN.
(*Centralblatt f. Physiologie.*)

The interpretation of such curves has proved a difficult prob-

lem, and no dogmatic statement can be made as yet. We have been accustomed to rely more or less upon the well known researches of Chauveau and Marey made upon the heart of the horse. Some recent experiments, however, have been made by Rolleston,[30] under the direction of Roy, which show that the curves obtained from the horse's heart by the French physiologists are not the same as those given by the rabbit or dog, and that possibly the explanation of their curves, given by Chauveau and Marey, may need revision. Rolleston made use of a new manometer, for the description of which reference must be made to the original paper. It is sufficient to say that the pressure in the contracting heart was measured by the torsion of a steel ribbon, the angle of torsion being written by a lever attached to the ribbon. As it is well known that the torsion is exactly proportional to the



TRACING OF ENDOCARDIAL PRESSURE FROM ROLLESTON.—(*Journal of Physiology.*)

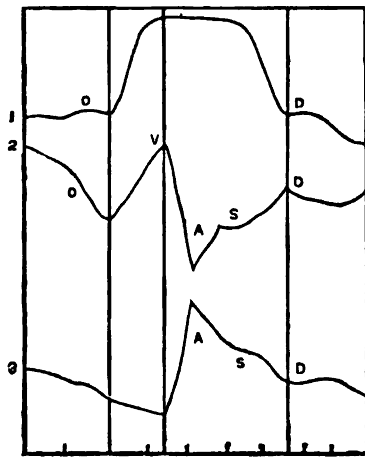
twisting force, in this case the contraction of the ventricle, his curves give exact measurements of the variations of pressure in the heart. The cannula connecting this manometer with the heart was introduced into the heart either through the tip of the auricle, or through the apex of the ventricle. In either case an opening was made in the thoracic wall, though in a few instances the cannula was introduced into the ventricle without opening the thorax at all, by thrusting a trocar through the thoracic wall into the left ventricle of the heart and connecting the trocar with the manometer. By either method of operating, the results were the same. The curve of endocardial pressure obtained by the latter method is shown in the figure. The important points which he makes are as follow: Contrary to a statement of Chauveau and Marey, there is no preliminary rise of pressure in the ventricle from the systole of

the auricle. If any such rise occurs, it falls in with the general systolic rise of the ventricle, and does not come out as a separate curve. Possibly this difference between the two observers may be explained by the fact that the heart of the horse beats much slower than that of the dog. The bursting open of the semilunar valves occurs somewhere between A and B, more accurately in the upper third of the line AB. Rolleston determined the time of the opening of these valves by the same method as that used by Martius and Edgren, viz., by comparison with simultaneous tracings of the carotid pulse. Unfortunately his results differ from those of the other two observers. The difference in the animal used for experimenting cannot be considered sufficient to explain the discrepancy. The method used by one or the other of them must be at fault, or some error must have been made in calculating the time of transmission of the pulse wave from the heart to the carotid. The closure of the semilunar valves Rolleston places at D of his curve, while according to most authors this act occurs somewhat later, as already explained. He gives no proof of the accuracy of his statement. It is a simple conjecture upon the ground that these valves could not remain open any appreciable time after the beginning of diastolic expansion. His curves also show in a number of cases that the pressure in the ventricles during the diastolic expansion may become negative by an amount equal to 20 mms. of mercury, when the thorax is open, thus agreeing with the previous experiments of Goltz and Gaule. Rolleston explains this negative pressure by the elastic resilience of the ventricular walls, which continues to be felt even after blood begins to enter the ventricle from the auricle. This explanation cannot be accepted, since the experiments of Martin and Donaldson[31] have shown conclusively that the ventricles in diastole in the opened thorax exert no suction power at all upon the flow of blood from the auricles. That is, the ventricle considered alone as a mechanical pump, outside of its relations to the negative pressure in the unopened thorax, acts simply as a force pump, and not as a suction pump. These experiments were made upon the isolated heart of the dog kept alive by defibrinated dog's or calf's blood. In all cases the thorax, of course, was widely open, and in some cases the pericardium was also cut away in order to give the heart the greatest possible freedom in expanding. The outcome of the experiments

in the author's words was "that once the aspirations of the thorax had been eliminated, the right auricle of the mammalian heart will not receive blood unless supplied to it under a decided, if small, positive pressure." The negative pressure shown by the instrument of Rolleston, then, could not have been caused by the elastic resilience of the walls of the ventricle. It seems much more probable that it was, as shown by Moens, the result of the quick emptying of the ventricle, in consequence of which, as proved upon an artificial heart working under the same conditions, there is always a short post-systolic negative pressure which is too brief to affect the auricles and has therefore no influence upon the flow of blood from the auricles into the ventricles.

By still another method, Fredericq[32] has attempted to determine the meaning of the cardiographic curve. After the manner of Chauveau and Marey, he introduced a sound into the heart of a large dog, and compared the tracing thus obtained with a tracing of the carotid pulse made by a Marey's sphygmograph, and with the tracings of a sound passed into the œsophagus until it came to lie within the thoracic cavity. The tracings shown by the œsophageal sound differed according to its position in the thorax. When lying just beneath the heart with the animal upon his back, the contractions of the auricle and ventricle were registered as negative waves. Since this result was obtained also when the chest was opened, Fredericq explains it as owing to the recoil of the heart during contraction toward the diaphragm and sternum, the drag of the heart upon the œsophagus in this movement causing a dilatation of the latter which was registered by the sound as a negative wave. Fredericq's results can be easily understood by reference to the following diagrammatic figure given by him to show the relations between the three curves. 1, is the tracing of the sound in the ventricle, 2, of the œsophageal sound when lying dorsal to the heart, and 3, the sphygmographic tracing of the aortic pulse. O represents the contraction of the auricle, which Fredericq, in opposition to Rolleston, found in the dog. In curve 2 this appears as a negative wave. Immediately following comes the ventricular systole, which at first causes a positive wave in curve 2, because the semilunar valves are closed while the heart is contracting, and the walls of the heart press upon the œsophagus. All the various observers agree that the semilunar valves are not

thrown open at the beginning of the systole, but each has a different opinion of the exact period at which this event occurs. A glance at Fredericq's curves shows that he believes it to occur at the point V of the curve 2, where the sudden streaming of blood from the heart changes the positive into a negative pressure in the œsophagus, for the reason stated above. By examining curve 1, this is seen to be shortly after the intra-ventricular pressure has reached its maximum; while Martius thinks it is just at the time of maximum ventricular pressure, the apex of the curve, and Rolleston thinks it is shortly before this point is reached. The disagreement probably depends upon the different forms of apparatus used by the various observers. A and S upon curves 2 and 3, agree with similar waves upon curve 1 not shown in the figure, but identical with those represented in the well known curves of Chauveau and Marey during the time of the ventricular systole. Fredericq's curves, like those of Chauveau and Marey, indicate that the dicrotic wave of the pulse (D of curve 3) begins just at the moment of the closure of the semilunar valves which in curve 1 he places at D. This wave, therefore, must be a wave of oscillation or reflux caused by the sudden closure of these valves. His results, consequently, though obtained from the dog, corroborate entirely those of Chauveau and Marey in their experiments upon the horse, the apparatus used for recording the changes of pressure being the same in both cases.



FREDERICQ'S CURVES.
(*Archives de Biologie.*)

Under certain conditions, the normal regular contractions of the ventricles are replaced by incoördinated trembling movements or fibrillar contractions, which are incapable of expelling the blood. The conditions under which this phenomenon appears have been made the subject of special study by MacWilliam.[33] It is known that fibrillar contractions can be caused readily by the application of strong electrical currents to the ventricle. MacWilliam proves that the result in this case is not owing to the stimulation of nerve

trunks or nerve centres in the heart, since it may follow when the stimulus is applied to the apex of the heart where no nerves exist. Moreover, by cutting the ventricle so that its apex is connected by a zigzag strip with the base, stimulation of the apex will start fibrillar contractions which travel along the zigzag isthmus to the base and finally involve the whole ventricular substance. The complexity of this movement in the mammalian heart, when the whole substance of the ventricle is agitated by irregular fluttering movements, is explained by the anatomical complexity of the course of the muscle fibres; while the persistence of the movements, often lasting for a long time after the stimulus has ceased, must be explained by the great irritability of the ventricular muscle. In the normal and vigorous heart, it is sometimes necessary to use a very strong current to bring on the condition of fibrillar contractions, while in other cases where the heart is weakened, it becomes remarkably sensitive in this respect, so that the slightest current or simple contact is sufficient to throw it into this condition. MacWilliam points out the danger that may follow from electrical stimulation of the heart in cases of sudden cardiac failure, as, for instance, syncope from the administration of chloroform. Stimulation of the heart under these conditions may easily throw it into fibrillar contractions, from which most probably it will not recover. He finds in addition that fibrillar contractions may be induced by the action of depressing drugs, for instance, by injecting into the blood a strong solution of bromide of potassium. With regard to the explanation of this form of cardiac contraction, he thinks that it is owing to a rapid succession of incoördinated peristaltic movements. Similarly strong stimuli applied to the auricles set them into a "rapid flutter," not an incoördinated fibrillar contraction, but a series of very rapidly succeeding contractions originating in the stimulated area; the whole appearance is simpler than in the ventricles chiefly because the arrangement of muscular fibres is so much less complex. An interesting point made by MacWilliam is that stimulation of the vagus prevents strong direct stimulation of the auricles from having the effect described; the simultaneous stimulation of the vagus appears to act by weakening the individual contractions to the point of invisibility. On the other hand, fibrillar contractions of the ventricle in consequence of faradic stimulation, are not affected by the

action of the vagus. In this point MacWilliam's results differ from those obtained by Laffont[34] in a similar series of experiments. Like MacWilliam, Laffont found that strong induction shocks sent directly into the heart will usually kill it beyond recovery, the heart subsequently showing only a few trembling movements (fibrillar contractions). But if during this faradization of the heart, the vagus nerve is stimulated, the strong shocks applied directly to the myocardium cause only a single energetic systole, and after the stimulation of the vagus has ceased, the heart returns to its normal contractions. In some way the stimulation of the inhibitory nerve of the heart enables it to bear without injury an electrical excitation which, without this inhibition, would have caused immediate death. The difference between the results of MacWilliam and Laffont in this respect may possibly be explained by supposing that the beneficial effect of stimulation of the vagus is only obtained when it precedes the direct stimulation of the heart. After the fibrillar contractions have appeared vagus stimulation has no effect, as stated by MacWilliam.

The interesting theory of Gaskell[35] with regard to the nature of the action of inhibitory nerves has received substantial support from some of his recent experiments upon the heart of the tortoise. Gaskell's theory in its most general form is that all the tissues are provided with nerve fibres of two kinds—one he calls katabolic since their impulses start destructive chemical changes in the tissues, and the other anabolic, since their impulses inaugurate constructive or synthetic changes in the tissues. The motor nerves belong to the katabolic class, the inhibitory nerves which, in connection with the muscles, cause relaxation, belong to the anabolic class. With regard to this theory it is well known that motor nerves cause destructive or katabolic changes in the muscles to which they are distributed, such as the formation of CO_2, sarcolactic acid, etc. But no proof at all has been given that the inhibitory nerves cause anabolic changes. Gaskell now offers some probable evidence in favor of this side of the theory. It is well known with regard to muscles that stimulation of the motor nerves causes in the muscle certain changes of electrical condition of such a character that the contracting muscle is electro-negative to the resting muscle, and, since this condition of negativity is associated with motor phenomena and katabolic changes, it seems to be an

allowable inference that if the action of an inhibitory nerve can be proved to cause the opposite electrical condition, namely, an increase of positivity in the inhibited over the resting muscle, then this condition must be associated with the opposite phenomena of anabolic changes. This, in brief, is what Gaskell has demonstrated upon the heart of the tortoise. In this animal the connection of the sinus with the auricle and ventricle can be severed without interrupting the strand of vagus fibres passing to the auricle and ventricle. Immediately after this connection of the sinus is broken, the auricle and ventricle come to rest for a variable time, as in the first ligature of Stannius. If during this period of rest, before the auricle and ventricle had again begun to beat, the vagus nerve was stimulated in the neck region, he found that with each stimulus there was a marked positive variation shown by the galvanometer needle, the galvanometer having previously been connected with the heart by means of non-polarizable electrodes. When the automatic contractions of the auricle began each contraction was accompanied by a strong negative variation, the galvanometer needle swinging in the other direction. In connection with this work Gaskell,[36] in a second paper, describes experiments made to determine the effect of muscarin stand-still of the heart upon its electrical condition. This drug, as is well known, stops the heart contractions, and according to the theory of Schmiedeberg, it has this action because it stimulates the endings of the vagus in the heart. Since Gaskell has shown that inhibition of the heart by electrical or chemical (NaCl) stimulation makes the heart muscle electro-positive, it would seem that muscarin also, if it acts in the way supposed by Schmiedeberg, ought to have the same effect. Gaskell's experiments prove that this is not the case, and that muscarin therefore causes heart stand still by paralyzing the motor mechanism. According to his well known views, the contractions of the heart are of myogonic origin, and therefore in his opinion the paralyzing action of the muscarin is directly upon the heart muscle. These experiments were not made upon the ventricle but upon the sinus (of the heart of the tortoise). It was found that after the sinus had been brought to a stand-still by the action of muscarin, without any change in its electrical condition, stimulation of the vagus still caused this muscarin-stopped portion of the heart to show a positive variation upon

the galvanometer. Similar experiments were made upon the effect of stimulation of the augmentor (accelerator) nerve fibres to the heart after it had been brought to rest by muscarin. According to the strength of the dose, three effects were obtained: first, when the dose applied to the sinus is just sufficient to cause stand-still, stimulation of these nerves caused the heart to make a series of regular beats; second, with a slightly larger dose stimulation of the nerves produced no visible effect upon the ventricle, but caused its muscular tissue to become negative in sign; third, with a still larger dose, stimulation of these nerves was without effect, either mechanical or electrical. In the same way, when the ventricle was brought to a stand-still by means of a clamp in the auriculo-ventricular groove, stimulation of the augmentor nerve, while it caused no contraction, did produce an electrical change of the same sign as that which accompanies muscular contraction. Presumably in such cases, upon Gaskell's theory, the katabolic changes resulting from the stimulation of the motor nerves, while not sufficiently great to cause a shortening or contraction, were sufficient to cause a change in electrical condition. It is quite possible of course, though no such supposition is entertained by Gaskell, that the negative electrical changes in the muscles of the heart and the katabolic changes in the fibres leading to contraction, have not the close causal connection assumed in his theory: they may be to a certain extent independent though simultaneous phenomena. Whether or not this is so, in fact the truth or error of Gaskell's whole theory will doubtless be developed in his own future researches. Meanwhile his facts are interesting and valuable.

Ringer and Buxton[37] have extended the researches begun by Ringer upon the effect of calcium, potassium, and sodium salts upon the contractility of the heart. The former series of experiments were made upon the frog's heart, the present series upon the heart of the eel. Practically the same results were obtained in both cases. If the heart after being fed by serum or blood until it was brought into good condition was given salt solution, 0.6 per cent., it quickly ran down and ceased beating. From this condition it could not be recovered by the action of sodium or potassium salts (bicarbonate of soda—chloride of potassium), but the addition of lime salts, especially calcium phosphate, to the circulating medium quickly restored its contractility, though when

added alone, it finally caused spasm and fusion of the beats. They find that a circulating liquid containing calcium phosphate and potassium chloride (the latter antagonizing the excessive stimulating action of the calcium salts) was capable of keeping the heart beating with great regularity for several hours.

The action of the bile upon the heart according to the experiments of Spallitta[38] upon the frog's heart is to diminish the contractions, and finally cause complete stand-still. This action he thinks, is not owing to the bile dissolving the red corpuscles, and in this way preventing the nutrition of the heart muscles, nor to the production of blood clots,—both of which theories have been advanced. He finds that the application of bile or the bile acids to the excised heart has the same effect as when in its normal relations. The disturbances of the heart in slight cases of icterus may be explained in the light of these results as the direct action of the absorbed bile upon the heart. The destruction of the red corpuscles with its accompanying phenomena can occur, in the author's opinion, only in cases of serious bilious intoxication, when the absorption of bile has passed a certain limit. The physiological explanation of the direct action of the bile or its acids upon the heart is that they stimulate the inhibitory nerve fibres in the heart. As some support to this theory, he states that atropin, which is known to paralyze the inhibitory fibres, antagonizes the action of bile.

SECRETION.

Bayliss and Bradford, in a communication published in 1886 upon the electrical variations of the salivary glands following upon stimulation of the cranial and sympathetic fibres going to the glands, found that in the dog excitation of the cranial fibres supplying the parotid in the submaxillary caused the surface of the gland to become negative to the hilus, while stimulation of the sympathetic fibres caused the surface of the gland to become positive to the hilus. In the cat somewhat different results were obtained; excitation of the cranial or the sympathetic fibres going to the submaxillary caused usually a diphasic variation. Bradford[39] has taken up the work again to determine, if possible, which of the many changes occurring in these glands upon stimulation of the secretory nerves, is responsible for these electrical changes. He concludes that the vaso-motor effects have nothing to do with the

changes in electrical potential noticed. With regard to what he calls the first phase, that in which the surface of the gland was negative to the hilus, it was invariably found that it was connected with a flow of the secretion. In the dog, where stimulation of the sympathetic fibres as a rule caused no flow of saliva, this phase never appeared; in the exceptional cases where stimulation of the sympathetic fibres did cause a flow of saliva, this first or negative phase appeared, preceding the usual second or positive phase. By a course of reasoning not altogether conclusive, Bradford decided that this first phase was not owing simply to the flow of saliva along the ducts of the gland, but was a consequence of the stimulation of the secretory fibres (in Heidenhain's sense of the term secretory as opposed to trophic) of the gland, and was caused either by the passage of the liquid of the secretion through the walls of the alveoli, or more probably by the changes in the gland cells which result from the stimulation of these fibres. The second phase in which the surface of the gland became positive to the hilus, a condition resulting in the dog from a stimulation of the sympathetic fibres, was undoubtedly connected with the metabolic (katabolic) changes in the cells leading to the formation of the organic portions of the secretion, and the result, therefore, of the stimulation of the so-called trophic fibres. The reasons for this conclusion were that it occurred most clearly in stimulation of the sympathetic branches to the gland (in the dog containing chiefly trophic fibres), and least marked in the stimulation of the chorda fibres, containing but few trophic fibres. Secondly, it varied with the viscidity of the saliva, that is the quantity of organic material in it. Thirdly, it could not be prevented easily by treating the gland with atropin, while on the contrary the first phase was easily prevented by this means, which accords with the fact that the action of the trophic fibres on the salivary glands is destroyed with much more difficulty than the action of the secretory fibres by the use of atropin.

The chief interest of this work lies, perhaps, in the bearing it has upon the theory of Gaskell with regard to the action of inhibitory nerves. As already explained, Gaskell thinks that inhibitory nerves cause anabolic changes in the tissues to which they are distributed. One of the best proofs he offers for this view is the fact that while stimulation of the motor nerves of the heart gives a negative variation of the electrical condition, stimulation of

the inhibitory nerves gives a positive variation, and since the first is connected with katabolic changes, the second is supposed to be connected with the opposite condition of anabolism. Bradford's work seems to throw some doubt on this last conclusion, since in the salivary gland stimulation of the trophic fibres gave electrical changes of a positive sign, and it is exactly these fibres which are supposed to cause katabolic changes in the gland. On the other hand in stimulation of the secretory fibres if metabolic changes of any kind are produced, they are probably of a katabolic nature, and yet electrical changes of the opposite sign result. It seems possible, then, that the different electrical conditions of the heart resulting from stimulation of different nerves may not furnish any indication of the kind of metabolic changes caused by their action.

In the mucous cells found in the membrane covering the retrolingual lymphatic sac of the frog Ranvier[40] has described the presence of vacuoles. These vacuoles may increase or diminish in size, may fuse or may vanish altogether. In the present paper he describes minutely the movements of these vacuoles, showing that these movements are connected with the life of the cell, that anything which kills the cells destroys at once the movements of the vacuoles. Furthermore by a new histological process he has been able to stain the mucus in these cells without staining the protoplasmic reticulum or the vacuoles. He has demonstrated by this means that the vacuoles are not in the substance of the mucus, that on the contrary they appear only in the protoplasm, either along the basal border of the cell or in the reticulum. With regard to their function, he believes that they are formed within the protoplasm, that they burst while in the cell, and the contained liquid escaping from the free border of the cell carries along with it some of the mucigen and in this way forms the secretion of mucus. Ranvier's discovery is very interesting and may have a wide application in the general theory of secretion though Ranvier does not attempt to draw any theoretical conclusions. One of the most difficult phenomena to explain in secretion is the formation of the water. In many cases it is known to be under direct nervous control, and Ranvier's description of the vacuoles in these simple mucous cells tends to confirm the view that the water of secretion is not simply a filtration or diffusion product, but that in some way it is produced by the activity of the cell protoplasm.

Biedermann[41] also reports that he has seen vacuoles in the cells of mucous glands, and that they can be obtained most easily after stimulation of the secretory nerve or after the injection of pilocarpine.

DIGESTION.

Stomach.—The question of the origin of the free hydrochloric acid formed in the stomach during digestion has been the subject of several investigations during this year. There are at present two important theories with regard to the formation of this acid. According to Heidenhain it is formed in the stomach from the chorides of the blood by the metabolic activity of the border or oxyntic cells of the gastric tubules. He does not suppose that these cells manufacture the acid directly from the chlorides, but most probably they form first an organic acid which destroys the chlorides with the product of free hydrochloric acid. According to Maly the hydrochloric acid exists preformed in the blood, and is separated out by the action of the gastric glands in somewhat the same way that the urea of the blood is eliminated by the kidney tubules. Some recent researches of Stricker and Hübner[42] upon the relations between the secretions and excretions of the body tend to confirm this latter view. These authors find that upon the same individual, under the same conditions of nutrition the total acidity of the urine is constant.

Variations in the acidity are caused by muscular work, menstruation, etc. But the acidity varies most definitely with the variations in the production of acid in the organism, and especially in the stomach. If the acid formed in the body is removed either artificially or accidentally, as in vomiting, the acidity of the urine is diminished. Moreover the curve of daily variation in the acidity of the urine follows exactly, though in an opposite direction, that of the secretion of acid by the stomach in digestion, that is during the period of stomach secretion the acidity of the urine decreases. This result would be expected upon the theory of Maly, since the alkaline radical which remains in the blood after the formation of hydrochloric acid from the chloride of sodium would be excreted by the kidneys, and thus cause a diminution in the acidity of the urine. The authors state further that the alkalinity of the blood tested by the method of Zuntz shows an increase at the time of gastric digestion which also would fit into the theory of Maly.

This latter statement, however, meets with some contradiction from experiments made by V. Noorden,[43] who endeavored to determine whether or not the alkalinity of the blood increases during the period of gastric digestion. He did not use the direct method of Zuntz for testing the alkalinity of the blood, but according to the method of Waller determined the quantity of CO_2 in a given bulk of blood before and during digestion; the idea being that if the alkalinity of the blood is increased a greater quantity of CO_2 will be held in a given amount of blood. His experiments gave negative results; the variations in the CO_2 were too irregular to justify any positive conclusions. He concludes, however, from his experiments that the alkalinity of the blood determined by the method stated, is not increased during the digestion of a heavy meal. It is obvious that with such an unsatisfactory method of working, but little value can be placed upon his conclusion. Recent experiments of Gruber[44] upon the influence of the sodium chloride of the food upon the reaction of the urine have also an indirect bearing upon the theory of acid secretion by the stomach. Gruber finds, as others have described, that a dog fed upon a diet poor in sodium chloride, *e.g.*, pure meat, always shows a weak alkaline reaction of his urine for two hours after the meal, though in the third or fourth hour the reaction again becomes weakly acid or neutral. If, however, a dog is kept on such a diet for several days until the secretion of NaCl in the urine becomes constant, and then a large proportion of NaCl is suddenly given with his food, the reaction of the urine becomes at once intensely alkaline with the accompanying phenomena of turbidity and precipitation of phosphates. This may continue for twelve hours or more after the meal, but if the same proportion of NaCl is given in the food for several consecutive days, the reaction of the urine even on the second day becomes normal, and remains so as long as the dose of NaCl is not altered. This last fact is to be explained by the results obtained from nutritional experiments with other substances, according to which it is probable that on the first day of increased NaCl food, the amount of NaCl excreted in the urine was less than that taken as food, while on the succeeding days a NaCl equilibrium was established, as much being excreted from the body each day as was received into it. The bearing of Gruber's work on the subject in hand lies in the fact that he shows that this apparent storing up of NaCl in the body on

the first day of increased NaCl feeding is in reality only an increased destruction of NaCl in the body with the formation of hydrochloric acid and free alkali. And it is the latter which, in the form of carbonate, gives the excessive alkaline reaction to the urine during the first day. It is not possible to explain this increased alkalinity except upon this hypothesis. But Gruber does not believe that Maly's diffusion theory, according to which the decomposition takes place in the blood, the free acid being then secreted by the stomach, will suffice to explain his results. He seems to think that if the acid was formed in excess in the blood it would be eliminated by the kidneys, and thus make the reaction of the urine acid and not alkaline. His own belief is in the line of Heidenhain's hypothesis, that the gastric cells in some unknown way break up the excess of NaCl, secreting the acid and leaving an alkaline residue in the blood which is in turn eliminated by the kidneys. Since Maly's theory seems to take it for granted that free hydrochloric acid in the blood can only be eliminated through the gastric glands, those who adhere to his view will find no difficulty in reconciling Gruber's results to their theory. The outcome of these different researches seems to be that no theory of the formation of hydrochloric acid in the stomach can be definitely stated as yet. We must await further researches. Inasmuch as the secretion of the stomach is periodic, and there is some proof that it is under the control of the nervous system, Heidenhain's theory agrees more nearly with what our knowledge of the phenomenon of secretion in general would lead us to expect. In this connection it is interesting to notice some experiments made by V. Noorden[45] upon gastric digestion in 14 cases of melancholia, as a contribution to nervous dyspepsia. He found that the total acidity of the stomach reached a percentage of 0.28 to 0.4 per cent., an amount rarely attained in the normal individual. This hyperacidity was owing to the increase of HCl, and the patients digested meats quickly and completely. The increased secretion of the acid he attributes to the nervous system, regarding the phenomenon as a true secretory neurosis.

A number of observations are reported by Cahn[46] upon the normal digestion of meat in the healthy stomach. His experiments were made chiefly upon dogs, since with them the conditions could be kept more constant. He found, for instance, that in a

dog kept under constant conditions of nutrition the degree of acidity of the stomach one hour after the ingestion of food was very nearly the same during a long period, varying only from 1 to 1.3 parts per 1000. In animals fed upon a preparation of *carne pura* whose digestion was examined at different intervals after the ingestion of the food, by washing out the stomach with a stomach pump, the following facts were established with regard to the phenomena of normal digestion. Warming the food caused a marked increase in the acidity of the stomach contents, as exhibited in the accompanying table:

45° C.	gave an	acidity of	1.8	parts of	HCl	per 1000
40° C.	"	"	1.5	"	"	"
35° C.	"	"	1.4	"	"	"

while on the other hand, cooling to 5° C. caused no marked diminution in the acidity. Warm foods and drinks, according to this, should have no direct effect in increasing the acidity of the stomach. As the digestion proceeds Cahn found that the relative quantity of acid increased, but the absolute quantity remained nearly constant, so that the maximum flow of digestive liquid seemed to occur at the beginning of digestion. Cahn suggests that in the therapeutic use of HCl to aid digestion, the indications are that the acid should be given during this period. The formation of digestive products, peptones and syntonin, begins very quickly after the ingestion of food; even at the end of the first half hour these products can be found in the stomach contents, and during the second half hour the passage of food into the intestines has begun. Cahn thinks that the largest portion of the albuminous food which gets into the intestines does so only after being peptonized. The amount of syntonin found in the stomach was always small comparatively, but was found throughout the whole period of digestion. The small amount present at any one time was explained upon the supposition that it was transformed to peptone as quickly as it was formed. Perhaps one of the most interesting results of Cahn's experiments was his determination of the acidity of the stomach in man during the digestion of 50 grms. of the powdered *carne pura*. The results obtained from two men are shown in the following table:—

	A.	B.
30 min. after digestion,	0.74 parts per 1000.	0.74
60 " " "	0.82 " "	1.64
90 " " "	0.99 " "	1.86
120 " " "	1.40 " "	2.88
150 " " "	2.46 " "	2.22
180 " " "	Stomach empty.	Stomach empty.
Average acidity equals	1.28	1.86

The figures show that the degree of acidity in the human stomach during digestion is about the same as in the dog. Whereas, from the analyses of Bidder and Schmidt in a case of gastric fistula, it has genereally been stated that the acidity of the human stomach was much less.

Clermont[47] contributes a new method of making peptones from albumins without the use of pepsin. His method is to enclose 20 grams of finely divided meat, 30 grams of water and 0.5 gram sulphuric acid in a sealed tube, and heat this mixture for six hours at a temperature of 180° C. in an oil bath. The tube is afterward opened, the contents dried, and extracted with water. The solution obtained is, according to his statement, peptone, though the reactions he gives are not sufficient to prove this statement according to the tests now used to demonstrate true peptone. The reactions he gives are that the solution was not precipitated by boiling, nor by the addition of mineral acids, but by excess of alcohol, by tannic acid, mercuric chloride, etc. If the acid was omitted in the heating experiment, a substance corresponding to syntonin was formed. The author suggests that the method will be found convenient for preparing peptones and syntonins for therapeutical purposes. The use of syntonin in such cases is rightly urged as more useful than that of peptone, since it gives the stomach something which is easily converted into peptone, and yet will require some functional use of the digestive glands.

Small Intestines.—Röhmann[48] has undertaken a renewed investigation of the process of absorption and secretion in the small intestines, making use of the Thiry-Vella operation of isolating a piece of the intestine and bringing the two ends to openings in the abdominal wall. Numerous experiments made by this method have given discordant results with regard to the quantity of intestinal secretion. Röhmann's observations, fortunately, give an explanation of these discrepancies. He finds that the quantity of secretion obtained depends upon the position of the loop of the intestine

isolated. If taken from the lower portion of the intestine the secretion is considerably greater than when taken from the upper portion. In the upper portion, in fact, he often obtained large masses of nearly solid mucus, the liquid secretion not being sufficient to dissolve it. The diastatic action of the intestinal secretion has also yielded different results in the hands of different observers. Here again Röhmann finds that the result obtained depends upon the portion of intestine experimented upon. In the upper part a comparatively rich formation of diastatic ferment takes place, while in the lower part only traces of such a ferment can be detected. Similarly the various accounts of the presence or absence of invertin, the ferment capable of transforming cane sugar to grape sugar, are reconciled by the statement of Röhmann that the ferment is found in the upper but not in the lower portion of the intestine. From a series of experiments made upon the absorption and secretion in the intestines with a number of different food substances, etc. (salts, peptones, grape sugar, starch) he concludes that these two processes cannot be explained as simple physical phenomena governed by the laws of filtration and osmosis. On the contrary both processes in his opinion must be considered as conditioned by the life activities of the cells of the intestine. In this conclusion the researches of Röhmann fall in with a general tendency shown in the last few years to discredit explanations of vital phenomena based directly upon ordinary physical laws.

Some interesting results upon the digestion of carbohydrate material have been obtained by Stutzer and Isbert.[49] Their experiments were made upon the digestion of wheat flour, clover hay, and bread, from which the fat had been extracted. The different diastatic ferments were tested with regard to the conditions under which their most powerful action upon carbohydrates was manifested. With reference to ptyaline prepared from the submaxillary gland of the pig, he found in accordance with other observers that it acted better in neutral than in either weakly acid or weakly alkaline solutions. Ptyaline had a stronger action upon carbohydrates than malt diastase, and the successive action of ptyaline and diastase gave no better results than when ptyaline alone was used. Extracts of the pancreas showed a weaker action than either ptyaline or malt diastase, and with this ferment as with the ptyaline the strongest action followed in neutral rather

than in alkaline solutions. With the successive action of ptyaline and pancreatic diastase upon carbohydrates no better result was obtained than when ptyaline alone was used, but using successively ptyaline in neutral solution, pepsin and pancreatic diastase, that is, imitating the process as it occurs in the body, the largest per cent. of the carbohydrate was dissolved. No explanation is given of the way in which pepsin aids the action of the diastatic ferments.

The absorption of fat in the intestine is still an unsettled question. Grünhagen[50] believes that the lymph leucocytes play no part in the process, that the fat particles pass at once from the lumen of the intestines into the body of the columnar epithelial cells, and can be detected there lying among the protoplasmic meshes of the cell. In this respect he partly confirms Schaefer's experiments upon fat absorption. By what process the fat particles are made to pass into the substance of the epithelial cells is not satisfactorily explained. From the bases of the epithelial cells the fat particles get into the lymphoid tissue of the villus and then reach the central lacteal. Other observers affirm that the lymph corpuscles push out between the epithelial cells, and ingest the fatty particles, and then pass back again to the lymphoid tissue of the villus. Mall,[51] in a report of some beautiful anatomical investigations upon the course of the blood and lymph vessels of the intestines, asserts that the central lacteal gives off finer lateral branches which pass outward to the epithelium, and extending between the epithelial cells really communicate with the lumen of the intestines. Mall's results were obtained upon the dog, and his discovery of this system of lymphatics makes it probable that in this animal at least neither epithelial cells nor lymph corpuscles take up the fat, but that it passes directly into these minute capillaries and through them reaches the lacteal.

Vignal[51] has studied carefully the action of the different micro-organisms which are found in the mouth and in the fæces. Using pure cultures of each organism he determined their effect upon certain typical food-stuffs, and also the influence of the different digestive liquids—gastric secretion, pancreatic secretion, bile—upon these organisms. From the details of his numerous experiments he concludes that the foods mixed with the saliva carry into the stomach a great number of organisms, and that some of these are destroyed by the action of this gastric juice, but a large number

are not. These latter enter the intestines with the chyme, and there in a neutral or slightly alkaline medium renew their activity and possibly aid largely in the solution of the albuminous foods. In the fæces the number of these organisms is greatly increased, and it seems quite probable that the active growth of these bodies in the alimentary canal must have some influence upon the contained food in preparing it for absorption. Something more definite in the same direction is found in recent publications by Kronecker and his pupils. Kronecker and Popoff[53] in their communication refer first to some previous work of Ott published in 1882, in which he demonstrated that fibrin digested in artificial gastric juice did not give in any stage of its conversion to peptone a substance which is capable of nourishing the isolated heart of a frog (that is, in the light of Martius' work does not furnish serum albumin). But if such a peptone solution, prepared by artificial digestion was brought into the stomach of a living animal for a short time, it became capable of nourishing the frog's heart; that is, it was converted to serum albumin. Kronecker and Popoff repeated these experiments and confirmed Ott's results. They used a frog's or terrapin's heart exhausted by NaCl solution as a test for the presence of serum albumin. They found that a peptone solution obtained by artificial digestion could be made nourishing to the heart by a stay of 15 minutes in the stomach of a living dog. Moreover, in a dog upon whom an intestinal loop had been isolated for over a year it was found that if such a peptone solution was brought into the loop it was converted in part at least into serum albumin within 10 min., while a solution of NaCl, 0.6 per cent., brought into the loop for the same length of time showed no nutritive action toward the heart, proving that the peptone solution had actually suffered a change, and not simply extracted something from the intestinal walls. With peptones formed in artificial pancreatic digestion an entirely different result was obtained; neither contact with the living stomach nor the living intestine was capable of transforming it to a heart nourishing liquid; that is, to serum albumin. They think it probable that in normal digestion neither stomach peptone (as produced in artificial digestion) nor pancreatic peptone is formed, but that the solid albumin is simply changed into a soluble modification, and this in turn may be converted to serum albumin in any part of the alimentary canal before absorption takes place. In a

continuation of this work by Kronecker and Brink,[64] they found that the stomach retains this power of changing peptone to a solution nourishing the heart (serum albumin) for only about 15 minutes after death. On the other hand if the non-nourishing peptone solution is circulated through the heart for a long time, the heart tissue itself causes the same change to take place; and even allowing the stomach peptone solution simply to stand for a long time, provided it has not been boiled, converts it to a heart-nourishing liquid. Blood serum containing true serum albumin loses its property of nourishing the heart when boiled, as would be expected; but if sterilized and kept antiseptically it will remain nourishing for weeks. Perhaps the most remarkable result obtained was with peptone solutions allowed to putrefy. In such solutions an apple-green color developed and microscopical examination showed in addition to a mould the presence of two bacteria, named by them, bacillus virescens and bacillus restituens. The former of these when grown in peptone solutions made it poisonous to the heart; the latter, however, has the power of converting the stomach peptone, in part at least, to serum albumin, or at least to a liquid which nourishes the heart. It seems an easy step to take to suppose that the converting action of the alimentary canal depends upon the presence of this bacillus. Strange to say the authors do not seem to have made any chemical examination of the substance which they call serum albumin produced by the transformation of the peptone. This is especially unfortunate since they state that serum albumin prepared from serum by the method of Hammantin does not nourish the heart. The general conclusions which they draw from their results are as follows: (1) Serum albumin is characterized more certainly by its power of nourishing the heart than by its physical or chemical properties. (2) Stomach and pancreas peptones are not albumins in physiological sense, that is, they do not nourish the tissues. (3) Stomach peptones can be converted to serum albumin by the action of many different kinds of cells and by one bacterium, viz., bacillus restituens.

Liver.—Several physiologists have shown experimentally that bile prevents the action of gastric juice in artificial digestion. But recent experiments seem to prove that in natural digestion the presence of bile in the stomach has no apparent effect. Dastre and others have introduced bile into the stomach of a dog during

digestion, either through the œsophagus or by means of a gastric fistula without injuring in any way the digestive powers of the animal. Oddi[55] has repeated and confirmed these experiments. He also succeeded in making a cholecysto-gastric fistula so that the bile all passed into the stomach. In this experiment he found that the bile did not prevent the action of the gastric juice in the first stages of digestion, and did not cause vomiting or gastric troubles as believed by many medical men.

It has been shown that muscle, kidney and lung taken from the body and kept alive by artificial circulation of blood furnish lactic acid to the blood, and may therefore be regarded as forming this substance in the normal course of their metabolisms. Wyssokowitsch[56] has attempted to determine whether liver treated in the same way causes an increase in the lactic acid or whether, as has been supposed, it is the organ in which this substance is destroyed or transformed into something else. Transfusion of the fresh liver with arterial blood, venous blood, and serum gave him in all cases a marked increase in the percentage of lactic acid in the blood used. It was proved that the lactic acid was formed in the liver de novo and not simply washed out since transfusing normal salt solution caused no increase in the lactic acid. The liver then must be classed with the muscle, lung, and kidney as one of the lactic acid forming tissues of the body. In what tissue or organ of the body the lactic acid suffers a further change has not yet been discovered.

In a series of experiments extending over several years Seegen[57] has studied the effect of various foods upon the production of sugar in the liver. The final results which he has reached are opposed to the ordinary views. He believes that the liver manufactures sugar, independently of its production of glycogen, from peptone, proteids, fats, and the components of fat, viz., glycerine and fatty acids; while on the contrary feeding with carbohydrates has no effect upon the production of sugar. These results were obtained both from feeding animals with the substances named, and also by allowing bits of the excised liver to stand in contact with the given substances for a certain time. Seegen's results have not passed unquestioned. For instance, Abeles[58] has made a number of determinations of the sugar in the blood of the hepatic veins and in arterial blood from the carotid taken at the same time. To

obtain the liver blood he made use of the method of Ikalowicz and Pal: that is, a catheter was introduced through the jugular and passed down into the liver veins. As the result of these experiments, he states that the sugar-manufacturing power of the liver can not be proved in this way, the difference in the quantities of sugar found in the two specimens of blood being too slight to justify such a conclusion. In consequence of these experiments Seegen[54] has repeated his determinations, making use of different methods for collecting hepatic blood. He made his experiments upon narcotized and non-narcotized animals. In the first series he found that the sugar in the portal vein was on the average 0.139 per cent., while that of the hepatic vein was 0.196 per cent., a difference in favor of the latter of about 40 per cent. In the series upon non-narcotized animals, the conditions under which his original experiments were made, the blood of the portal vein contained 0.102 per cent. of sugar, while that from the hepatic veins contained 0.232 per cent.,—a difference of more than 100 per cent. Seegen concludes from these experiments that the negative results obtained by Abeles were caused by the chloroform narcosis of the animal. It is well known that in chloroform narcosis the urine frequently contains sugar, indicating that the use of chloroform in some way increases the quantity of sugar in the blood generally, and thus vitiates the comparison between the liver blood and the blood of other parts of the body.

From a number of experiments upon rabbits in which artificial diabetes was produced by puncturing the medulla, Ransom[69] concludes that feeding with glycerine prevents glycosuria to a considerable extent. Furthermore he states that the action of the glycerine is more marked when taken into the stomach than when injected subcutaneously. According to the author, glycerine checks the glycosuria by acting directly on the liver cells, and preventing them from converting their glycogen into sugar, leading to an accumulation of glycogen in the liver. To test this theory he made analyses of the liver in animals to whom glycerine had been given and compared them with others made upon animals without glycerine. In the first case he found that the liver contained more glycogen and less sugar than in the second case, supporting his theory. With reference to the therapeutic use of glycerine in diabetes the author makes no positive statements.

In two patients upon whom the operation of cholecystotomy had been performed, a fistula forming as the result of the operation in each case, Birch and Spong[60] were able to collect what appeared to be the normal secretion of the gall-bladder. In amount the secretion was something over 20 cc. in 24 hours; it was usually quite clear and contained no bile at all, owing to the occlusion of the cystic duct. The reaction was distinctly alkaline, and chemical examination gave the following results:—

Water, ...	979.7 parts.
Solids, ...	20.3 "

The analysis of the solids gave

A. Organic, .	Mucin (and trace of albumin),	12.09 parts.
B. Inorganic, .	Chlorine, ...	3.84 "
	Carbon di-oxide, . . .	0.29 "
	Sodium (combined with Cl),	2.50 "
	Soda (combined with CO_2), .	0.41 "
	Potassium salts and phosphates, . . .	1.17 "

The secretion of the gall-bladder then contains no bile salts or biliary pigments. Physiologically, it was shown not to have any diastatic or emulsifying action. It cannot possess, therefore, any digestive value.

Movements and Innervation of Alimentary Canal.—Wassilieff,[61] under the direction of Kronecker, has attempted to localize the point in the mucous membrane of the buccal cavity from which the reflex act of swallowing starts. His experiments upon himself were entirely negative. Mechanical stimulation of every part of the mouth cavity which could be seen or felt failed to discover any spot stimulation of which led to a reflex act of deglutition. Upon rabbits he had better success. Like others he found that stimulation of the central end of the superior laryngeal always caused a reflex swallowing movement. But section of this nerve on both sides did not interfere with the ability of the animal to swallow its food normally. With regard to stimulation of the glossopharyngeal he corroborates the statement of Kronecker and Meltzer that inhibition of the swallowing movements is the result. His most satisfactory experiments were upon the soft palate. Mechanical stimulation of the soft palate from the middle of the tonsils to the hard palate, over an area about 2 ctm. long and 1 ctm. broad (with the exception of a median strip 1 to 2 mms. in width) invariably caused swallowing movements in the rabbit, no

matter how frequently repeated. When this area was treated with cocaine no reflex movements followed when it was stimulated. Moreover, section of the trigeminal nerve also completely prevented the reflex from this area. There seems to be no doubt that in this particular animal the reflex act of swallowing originates in the contact of food with this portion of the mucous membrane of the mouth. From what portion of the mucous membrane of the mouth cavity in man the sensory impulse for the reflex starts, the author was not able to discover, though he supposes the spot to lie behind the velum in the region of the tonsils.

Hlasko[62] has investigated the question of the cranial centre for the stomach movements, with results which lead him to conclude that the centre for the constrictor fibres of the cardia lies in the corpora quadrigemina, and that they reach the stomach chiefly through the vagus, but partly along the spinal cord and sympathetic system. The dilator fibres of the cardia originate in the corpus striatum just outside the fibres of the anterior commissure, and reach the stomach through the vagus. The centre for the movements of the stomach walls lies in the corpora quadrigemina, the efferent fibres pass to the stomach along the spinal cord, etc. From his experiments the author concludes that no such thing as a distinct vomiting centre can be demonstrated in the medulla. From his own work it is more probable that the centre for vomiting movements lies in the corpora quadrigemina.

Bokai,[63] in a series of papers, discusses some extremely interesting facts with regard to the intestinal movements. He found that simple distension of the intestine by injection of neutral gases, N, H and O, caused no movements. On the contrary when strong intestinal movements were in progress from dyspnœic excitation, then the injection of O caused the movements to cease. This inhibitory action of the O appeared to be local, since it occurred in a small loop of intestine completely isolated from the rest. From this experiment the author concludes that the intestinal movements are caused by some local peripheral stimulus. Injection of the gases CO_2, CH_4 and H_2S into the intestines started up active peristaltic contractions, and these movements were, in the case of the first two gases, completely stopped by a subsequent injection of O, while with H_2S subsequent treatment with O only partially prevented the contractions. In a second

communication the author turned his attention to the action of increased temperature upon the intestinal movements. As is well known the contractions of the intestines in fever patients seem to become more feeble and sluggish even though no trouble of the stomach or intestines is present. Bokai convinced himself of the truth of this belief by actual observation. In rabbits made feverish by the injection of septic material, the peristaltic movements, when the abdomen was opened, showed a marked diminution compared with a normal rabbit, and the intestines in the fever rabbit responded much less readily to mechanical and chemical stimulation. Since the intestinal movements are under the control of two sets of nerve fibres, one motor, reaching the intestines through the vagi, and one inhibitory, running in the splanchnics, the author endeavored to determine whether the sluggishness of the intestinal movements in fever is caused by an increase in the action of the inhibitory nerves or a diminution in that of the motor nerves. He found that in such animals section of the splanchnics increased the irritability of the intestines toward mechanical and chemical stimuli. The action of fever seems from this to be in an increased activity of the inhibitory nerves, most probably from a direct action of the heat upon the centres of these nerves. He showed also that the simple increase in the body temperature was responsible for this result, since if the animal was kept for a long time in a warm chamber so as to raise the body temperature the same effects were observed. Since the gases causing peristaltic movements, viz., CO_2 CH_4 and H_2S are all found in the intestines, the author was led to investigate the effect of other products of fermentation and putrefaction which occur in the same organs. He found that the following acids when injected into the intestines caused more or less violent peristaltic movements, viz., lactic, succinic, valerianic, butyric, formic, proprionic, acetic, caproic and caprylic, the comparative intensity of the action being shown by the order of enumeration,—caprylic acid having the strongest action and lactic acid the weakest. All of the acids acted more strongly on the small intestine and rectum than on the large intestine. Some caused accompanying vaso-constriction and some vaso-dilatation, so that their diarrhœic effect was independent of their action on the blood-vessels. This conclusion is more certain since of the two most active acids in this respect, acetic and caprylic, the acetic acid in

the small doses used caused vaso-constriction, while the caprylic acid caused vaso-dilatation. Not only was diarrhœa produced by the action of these acids, but with the stronger ones at least catarrh of the mucous membrane occurred. Since the acids named may all occur in certain proportions in the intestinal contents of man, there seems to be but little doubt that they play a useful rôle as peripheral stimuli to the muscular coats of the intestines; while if they occur in abnormal quantities they probably lead to pathological movements resulting in diarrhœa, or even to dangerous inflammation. Bokai also investigated the action of phenol, indol and skatol, all of which are found in small quantities in the intestines or fæces, and are to be considered as products of the pancreatic putrefaction of albuminous substances. Pure solutions of these bodies injected into the intestines gave the following results: phenol and indol were without any effect, while skatol caused violent peristaltic contractions even in very small doses, and in young animals (rabbits) might even lead to tonic contractions of the small intestine and rectum. As far as the blood-vessels were concerned, skatol caused first a constriction and then a dilatation. So that skatol also may take a useful part in intestinal peristalsis, and when existing above a certain proportion may cause diarrhœa. Unlike the organic acids mentioned, skatol did not produce catarrh of the mucous membrane.

RESPIRATION.

Since the time of Hutchinson it has been known that the respiratory movements of men are of the abdominal types while those of women are of the costal type. Inasmuch as very young girls among civilized races show this type of breathing before corsets and tight dresses are worn, it has been supposed that the difference was an essential one, and not a secondary result of the difference in dress. Mays[64] has had the opportunity to examine a number of Indian girls, some of them full-blooded and some with a mixture of white blood. He finds that in the true Indians the breathing, like that of men, is of the abdominal type, while those that showed a costal type were either one-half or three-quarters white. Such observations have long been wanted to settle the question, and Mays' result seems to leave but little doubt that the costal type among civilized women has been acquired from their habits of dress, and become hereditary in their female children.

The relations of oxygen in the blood have been satisfactorily determined, but in what way the CO_2 is combined or held in solution is still in large measure unknown. It is evident that a complete theory of the mechanism of gaseous exchanges in the body, both those in the lungs and those in the tissues generally, can not be obtained until this problem is solved. An actual advance in this direction has been made by Bohr.[65] The definite point which Bohr has determined is the amount of CO_2 which will combine with 1 grm. of pure hæmoglobin. With regard to the relations of oxygen in the body, we know that it is not held simply in solution in the plasma, but in a loose chemical combination with the hæmoglobin of the red corpuscles. It is known also that CO_2 is held in the blood not in simple solution, but in some sort of chemical combination; and the usual hypothesis has been that it is held as carbonate or bicarbonate of sodium. Lately evidence has been accumulating which goes to show that the hæmoglobin may also combine with the CO_2, and possibly has to CO_2 somewhat the same relation that it bears to oxygen. Bohr has shown from careful absorptiometric experiments that pure hæmoglobin solutions absorb large quantities of carbon di-oxide, and that a great portion of the gas thus absorbed forms a chemical combination with the hæmoglobin. He finds that 1 gram of hæmoglobin in solution at a pressure of 120 mms. of mercury will combine (chemically) with 3.5 cc. of CO_2, and that this compound dissociates at lower pressures: that is, the quantity of CO_2 combining with 1 gram of hæmoglobin decreases greatly with diminished pressure of the gas. We have now exact determinations of the behavior of oxygen and CO_2 toward hæmoglobin. It remains to be seen what its relations will be toward mixtures of the two gases.

A novel theory of the relation of the heart-beat to the gaseous exchanges of the body, especially to the elimination of the CO_2 from venous blood, has been proposed by V. Fleischl.[66] The theory was suggested by a very simple experiment which any one may perform for himself. The experiment is made with an ordinary glass syringe which is in good working order. Place the end of the syringe under water and slowly raise the piston until the syringe is about one-half full. Close the end, while still under water, with the finger, or better still with a stopcock if the syringe is provided with one, and then gently raise the piston to its full

height. The negative pressure in the syringe thus produced will cause a few bubbles of gas to form in the liquid, usually along the sides of the glass. Now lower the piston rod gently until the plunger again comes into contact with the liquid. Again raise it quickly for a short distance and release it suddenly; the plunger in a good syringe will strike the water sharply, and give it a sudden shock. If now immediately after giving this shock the piston is again raised to its full height and a negative pressure produced within the syringe, a comparatively enormous liberation of gas will take place,—so much in fact that the liquid seems to boil. V. Fleischl's explanation of this curious phenomenon is that the shock given to the liquid destroys the character of the solution of the gas in the water. In a true solution of gas the gaseous molecules enter into such close combination with those of the water that their physical properties as gaseous molecules are completely lost; they behave in fact like liquid molecules. The effect of the shock is to break up this combination: the gaseous molecules now lie loose, as it were, between the water molecules. We have a molecular mixture instead of a true solution. If in this condition, before a re-solution can take place, the liquid is submitted to a negative pressure, the gas is readily given off. A physiological application of this phenomenon is made by V. Fleischl to the venous blood sent by the right heart into the lungs. The quick contraction of the right ventricle gives this blood a sudden shock which probably extends through the whole area of distribution of the pulmonary artery. Immediately afterward this blood is placed under the negative pressure existing in the thoracic cavity. According to this syringe experiment, the gas contained in the blood ought now to be given off with special ease. He thinks that this shock of the heart is of particular importance to the CO_2 held in solution in the blood-plasma. He believes indeed that this preliminary shock is absolutely essential; that without it the CO_2 could not be removed quickly enough by the lungs.

The existence and position of a general medullary respiratory centre is still the subject of discussion and experiment in physiology. While it is the general belief that such a centre does exist in the medulla in the neighborhood of the calamus scriptorius, no satisfactory histological proof has been obtained of its exact location. The latest histological and experimental researches with regard to

this centre, those of Gierke and Mislawsky are not in accord. Langendorff[67] in a recent contribution takes occasion to bring forward again his well-known views, according to which a general respiratory centre in the medulla does not exist. His own theory is that the respiratory centres are found in the spinal cord in the gray matter where the different respiratory nerves arise; that these nuclei of origin are to be considered as automatie respiratory centres each for the nerve originating in it. While he speaks of these various centres as constituting a physiological unity, a respiratory centre, since they act in harmony with each, they do not form a single anatomical centre. The only influence of the medulla upon the respiratory discharges according to this view is that of a general regulating action. Langendorff's theory, first suggested many years ago by experiments of Brown-Séquard, has found a number of supporters, who have confirmed many of Langendorff's observations. In the present communication he offers some new experiments in favor of his theory. The experiments, made upon rabbits, consisted in completely dividing one-half of the medulla one or two. millimeters posterior to the calamus. As would be expected, the first effect of this section was a paralysis of respiratory movements upon the same side, but Langendorff states that this paralysis was only temporary; after a variable time respiratory movements again commenced on the injured side: first, movements of the diaphragm of that side, later, movements of the thoracic muscles. The explanation of this phenomena given by Langendorff is that the section paralyzed the special respiratory centres of that side by shock, but the respirations of the other side being sufficient to keep the animal alive, the spinal centres on the injured side in time recovered and normal respiratory movements were resumed. There is a general unwillingness to assent to this theory of spinal respiratory centres. The experiments hitherto made to demonstrate them have been explained easily in other ways by those who hold to the old view. The experiments related in the present paper can also be explained upon the theory of a respiratory centre in the medulla by supposing that cross connections between the bi-lateral respiratory centre and the efferent paths of the two sides exist even below the calamus, and that, therefore, the centre on the uninjured side was still able to send impulses to the respiratory nerves of both sides.

Further evidence for the existence of heat centres in the brain has been given by experiments of Ott and Carter.[68] The authors made lesions in different parts of the brains of rabbits through holes trephined in the skull. Thermometric and calorimetric observations were made upon the animals, together with records of the blood-pressure, respirations, etc. They conclude that they can locate four areas in the brain, lesions of which cause a rise of temperature and an increase in heat production. These four heat centres are situated as follows: First, in front of and beneath the corpus striatum. Second, the parts lying to the median side of the nodus cursorius. Third, the parts about Schiff's crying centre, that is, at some point between the thalamus and corpus striatum near the middle line. Fourth, the anterior inner end of the optic thalamus. The authors state that the variation in the circulation observed were not such as could explain the disturbances in heat production. It is to be regretted that the experiments were not made more definite by careful histological examinations of the parts of the brain involved in the lesions.

CENTRAL NERVOUS SYSTEM.

The physiology of the spinal ganglia is as yet an almost entirely unknown subject; but until within the past few years the famous observations of Waller upon the effect of the section of the posterior roots of the spinal nerve have been considered as proving the great nutritional importance of these structures to the sensory nerve fibres. The experiments of Waller have been contradicted by recent researches of Vejas (1883), a pupil of Gudden, and some of the fundamental views with regard to the histological and physiological connection of these ganglia with the sensory nerve fibres were made doubtful by his work. Within the past year, however, careful researches by Joseph[69] have thrown doubt upon the correctness of Vejas' statements, and re-established the original conclusions of Waller. A brief statement of Waller's experiments, and the work of Vejas will perhaps make clearer the interesting results obtained by Joseph. Waller's experiments consisted in section of the anterior and posterior roots of the spinal nerves, and complete extirpation of the spinal ganglia, and his work was completed by the experiments of Claude Bernard upon the result of section of the nerve beyond the ganglion. The results they obtained

were more or less completely corroborated by subsequent observers, and were as follow: Section of the posterior root between the ganglion and the cord was followed by complete degeneration of the fibres connected with the cord, while the ganglion and the common nerve trunk showed no degeneration. Section of the anterior root between the ganglion and the cord was followed by complete degeneration of the motor fibres in the nerve trunk, while in that part of the anterior root adhering to the cord no change in the fibres took place. Complete extirpation of the ganglion, which involved also section of the anterior root fibres, was followed by complete degeneration of the whole of the peripheral nerve, and of the posterior root fibres remaining in connection with the cord. The anterior root fibres in connection with the cord remained unchanged. Section of the nerve trunk peripheral to the ganglion was followed by degeneration of the nerve trunk toward the periphery, while the ganglion and the two roots connecting it with the cord remained unchanged. The conclusions from this work were that the nerve cells of the spinal ganglia serve as nutritive centres for the sensory fibres, and these degenerate in either direction when their connection with the ganglion is severed. The nutritive centres for the motor fibres on the other hand are contained in the spinal cord itself. These results were for a long time accepted as proved. Vejas, instead of sectioning the nerve roots and trunks, tore them apart and obtained entirely different results. After tearing apart both roots he found that the nerve fibres in the stumps adhering to the spinal cord, the motor as well as the sensory, completely degenerated. The ganglion on the other hand showed no change unless the nerve peripheral to it was divided, in which case the ganglion degenerated. Joseph has again repeated Waller's experiments, using, as Waller did, the second spinal nerve on account of the greater length of the roots. He re-establishes Waller's original statement that after section of the anterior root the peripheral end degenerates, while the central end remains normal. The nutritive centre for these fibres therefore must lie in the cord. Section of the nerve trunk peripheral to the ganglion is followed by complete degeneration of the peripheral nerve, and moreover a partial degeneration of some of the fibres in the ganglion and posterior root, though for the most part they remain normal, as stated by Bernard. Section of the posterior root causes

a degeneration of by far the greater number of fibres in the central stump, while the ganglion and the peripheral nerve trunk remain normal with the exception of a few fibres which undergo degeneration. With regard to the function of the spinal ganglia, Joseph again comes back to the original theory that they serve as regulating centres for the nutrition of the sensory fibres, both those of the peripheral trunk and those of the posterior root. The cells of the ganglion must be considered, then, as being in connection with the greater number of sensory fibres entering and leaving the ganglion. Since after section of the posterior root a certain number of the fibres in the ganglion and the nerve degenerate, Joseph concludes that these fibres have their origin and nutritive centre in the cord and run through the ganglion without connecting with any of the nerve cells.

This same subject of the physiology of the spinal ganglia has been investigated by Pregaldino,[70] making use of purely physiological methods. The author approached his subject in a very novel way. The particular point which he wished to demonstrate was whether or not the sensory fibres of the spinal nerve all end in the nerve cells of the ganglion before continuing on to the cord; that is, are or are not the ganglion cells interpolated in the course of all the sensory fibres? The idea with which he started out was that the cells of the spinal ganglia, like those of the cerebro-spinal centre, ought to be much more sensitive to withdrawal of the blood supply than the nerve fibres. If, therefore, the blood supply to a spinal ganglion was cut off as completely as possible, with the exception of the blood which may come to it along the posterior root and the peripheral nerve, it ought to die within a comparatively short time, and stimulating those of the peripheral nerve beyond the ganglion, should not cause any reflex actions. On the other hand, stimulation of the posterior root between the ganglion and the cord should produce reflex actions as usual. Experiments of this kind were carried out on frogs and dogs. In the former the 9th and 10th spinal nerves were used; in the latter the sacral nerves. The results were the same in both cases. It was found that if on one side the spinal ganglion and its posterior root were exposed, and the blood supply to the ganglion destroyed as completely as possible; while on the other side, for the sake of control, the spinal ganglion was exposed, but its blood supply left intact;

then in the former case, after a certain time, from forty to sixty hours with the frog, from sixteen to twenty hours with the dog, stimulation of the central end of the divided nerve beyond the ganglion was not able to cause any reflexes, while stimulation of the posterior root gave the usual reflex actions. On the other side in which the blood supply of the ganglion was intact, stimulation of both peripheral nerve and posterior root gave reflexes, the strength of stimulus for each being about the same. Furthermore in the frog the spinal ganglion is so placed on the side of the nerve trunk that it may be removed by a longitudinal section, in the direction of the nerve, without interrupting the anatomical continuity between the posterior root and the common nerve trunk. As a result of such section, however, stimulation of the peripheral nerve caused no reflexes whatever, which would tend to prove, together with the experiments given above, that the sensory fibres of the peripheral trunk all end in nerve cells in the ganglia, and removal or death of these cells blocks the nervous impulse ascending to the cord. In other experiments he was able to prove that direct local application of strychnine, atropine or morphine to the spinal ganglion had apparently no effect whatever, since after such application the same strength of stimulus, applied to the peripheral nerve or the posterior root, was necessary to produce reflex actions as before.

Circulation in the Brain.—The old subject of the circulation of the blood in the brain during sleeping and waking, which has been experimented upon in so many different ways, has been again investigated by Speht[71] by a new method. The animals used were rabbits. The circulation in the head was suddenly stopped, the head was quickly removed from the body, and then the total amount of blood in the head and in the whole body was determined. It was found that in waking rabbits the blood in the head (not in the brain alone) was on the average about $\frac{1}{8}$ of the whole amount of blood in the body; while in sleeping rabbits, the sleep being induced by chloral, the blood in the head was only $\frac{1}{11}$ of that in the whole animal. Whether normal sleep and chloral narcosis can be considered as having the same influence upon the circulation in the head can not be taken for granted without good proof.

The effect of various conditions upon the circulation in the

brain has been studied by Gärtner and Wagner[72] in the dog by tying a cannula into the external jugular, through which most of the blood from the brain returns to the heart, and determining the rate of flow under different conditions. Branches of the external jugular other than those coming from the brain were of course ligated. They found that the outflow of blood was not diminished by reflex stimulation of the vaso-motor centre, nor by dyspnœa. On the contrary, as the general blood pressure increased in consequence of such stimulation, there was a parallel increase in the quantity of blood flowing through the brain. Morphia was without influence on the brain circulation. Chloroform and amyl nitrite caused an increased flow through the brain in spite of a generally depressed arterial tension, because of their special action in dilating the brain vessels. Epileptic attacks produced by stimulation of the cortex of the brain were accompanied by hyperæmia instead of anæmia during the convulsions. Rummo and Ferranini[73] have made a study of the diurnal and nocturnal variations of the cranial pulse upon two individuals, each of whom had lost a part of his skull. The patients were kept under normal conditions and the pulse carefully registered. It was found that there was a well marked diurnal variation. After breakfast the pulse was stronger, toward the end of the day, from 4 to 6 P.M., it showed a diminished tension, and again became stronger after dinner. During normal sleep three different phases could be determined. In the first period, extending from 10 P.M. to 1 A.M., the pulse, as after eating dinner, was decidedly strong; in the second period, from 1 A.M. to 4 A.M., the pulse became weaker, and in the third period, from 4 A.M. to 6 A.M., this diminution of tone disappeared, and the pulse came back to its normal strength. At the moment of wakening, either in the morning or at any time during the night, a succession of short irregular pulse waves were always obtained which the authors named the "spasmodic period of the cerebral pulse." If the patient was made to reverse his normal habits and sleep during the day, then the three periods mentioned above did not appear. On the contrary there occurred a strong diminution of tonus not noticed in normal sleep. If the patients attempted to remain awake during the whole night the pulse also seemed to decrease steadily in tension, though the fall was interrupted by periods of reinforcement as the person struggled to overcome his drowsiness.

Physiology of the Cerebral Hemispheres.—Asch and Neisser[74] endeavored to determine from experiments upon rabbits, whether the gray matter of the cortex in the motor areas of the brain, or the underlying white substance is more easily excited by electrical stimulation. They concluded that the greatest motor effects are obtained when the stimulus is applied to the boundary line between the gray and the white matter, the real thing stimulated being, probably, the undermost layer of the gray cortex. In accordance with the results of other observers they found that stimulation of the underlying white matter frequently caused movements on the same side of the body, while stimulation of the gray matter, as observed by others, always caused movements on the other side of the body.

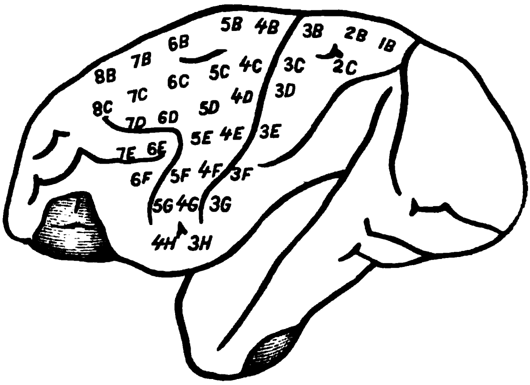


FIG. 1.—FROM SCHAEFER.—(Ludwig's *Beitrage f. Physiologie.*)

The well known results of Ferrier upon the localization of motor areas in the cortex of the cerebrum of the ape, so frequently criticised, have received an important confirmation from the experiments of Schaefer and Horsley,[75] a full account of which is to appear in the Philosophical Transactions. These gentlemen have carefully explored certain portions of the cortex in the monkey, using electrical stimulation and also extirpation. They have obtained definite results which are doubly valuable from the fact that they essentially corroborate the work of Ferrier. The portion of the cerebrum operated upon will be

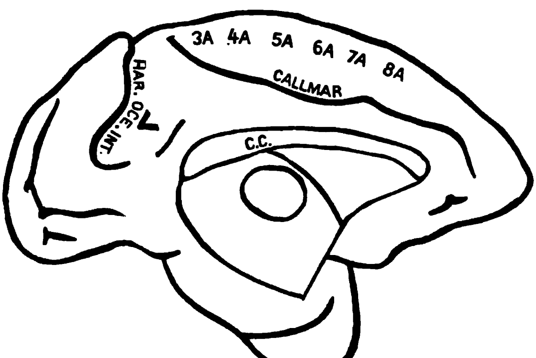


FIG. 2.—FROM SCHAEFER.—(Ludwig's *Beitrage f. Physiologie.*)

understood by reference to Fig. 1. It will be seen that they map out along the great longitudinal fissure eight equally large areas extending from the parieto-occipital fissure toward the front of the brain, and marked 1 B, 2 B, 3 B, etc. Extending laterally from 3 B along the posterior border of the central sulcus they mark other equal areas, 3 C, 3 D, 3 E, etc. In front of the sulcus is a parallel series passing outward from 4 B, and marked 4 C, 4 D, 4 E, etc. In front of these is a series 5 B, 5 C, 5 D, etc., and so on. Each of these areas has been carefully experimented upon, and the exact movements caused by stimulation of each area observed and compared with the results of Ferrier's work upon the same spot. The general outcome is that they confirm Ferrier's results, and make a number of important additions.

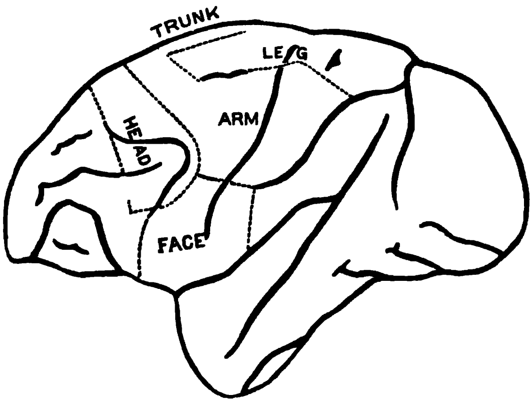


FIG. 3.—FROM SCHAEFER.—(Ludwig's *Beitrage f. Physiologie.*)

The most important addition perhaps was a determination of the area from the muscles of the trunk. This was found to extend along the gyrus marginalis, which was also laid off in a number of equal areas for purposes of stimulation, as shown in Fig. 2, 3 A, 4 A, 5 A, etc. The general position of the centres for the movements of the various muscles of the body as determined by them is shown in Figs. 3 and 4, the latter representing the results of stimulation of the gyrus marginalis. The centre for the muscles of the trunk is comparatively small and

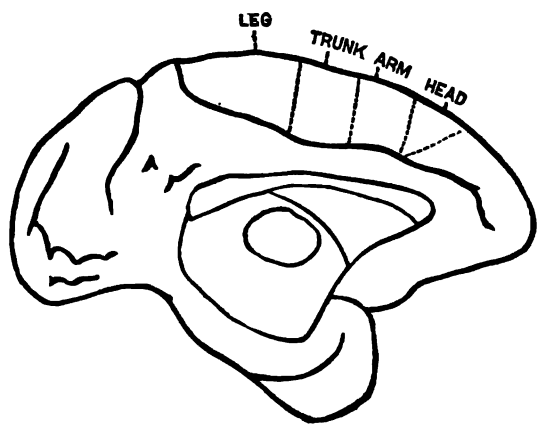


FIG. 4.—FROM SCHAEFER.—Ludwig's *Beitrage f. Physiologie.*)

includes the areas 5 A and 6 A of the gyrus marginalis, and 5 B and 6 B of the upper frontal convolution. The centre for the muscles of the leg is greater, comprising areas 3 A, 4 A and part of 5 A, of the marginal convolution, and areas 1 B, 2 B, 3 B, 4 B, 5 B, and 6 B, along the longitudinal fissure, and 2 C of the superior parietal lobe. The centre for the arm is still more extensive, comprising the ascending frontal and parietal convolutions (anterior and posterior central convolutions) throughout most of their extent. The head region when stimulated causes movements of the head, the eyes, the eyebrows and the ears: it lies in front of the arm region. The centre for the facial muscles lies round the lower end of the central sulcus. Schaefer points out that the sulci of the cortex which separate more or less completely the different convolutions cannot be considered as natural boundaries for the motor centres. Even the central sulcus does not form such a boundary. Stimulation of the immediate regions on both sides causes movements of the same group of muscles. The movements excited by stimulation of these areas resemble ordinary voluntary movements, in that they include, usually, the co-ordinated activities of several different muscles.

Carbonieri[76] contributes a clinical observation which gives some information as to the position of the olfactory centre. The patient suffered from a number of epileptiform convulsions during which he always complained of a nauseating odor not perceptible to others. Post-mortem examination revealed a tumor in the occipito-temporal and hippocampal convolutions,—the portion of the brain in which the olfactory centre has been placed by Ferrier, Munk and others.

Hun[77] reports several cases of lesions of the cerebral hemispheres which add to the clinical evidence in support of localized centres in the brain. In one case the patient showed a defect of vision in the lower left quadrant of each visual field. Post-mortem examination indicated atrophy of the lower half of the cuneus. In a second case the atrophy included the posterior central, the angular convolution and adjacent portions of the parietal lobe of the left side. During life the patient suffered from alexia and agraphia, but it is worthy of note that though the lesion was so extensive there was no impairment of vision or hearing. In a third case

there was an endothelioma lying close to the superior longitudinal fissure, and just behind the posterior central convolution of the right side, over the centre for the leg, according to the experiments of Schafer and Horsley upon the ape. During life the patient suffered from periodic convulsions of the left side, beginning always in the left leg.

The physiological functions of the optic thalami are practically unknown. In spite of the numerous researches made upon these bodies the results have been negative or contradictory. Bechterew[78] reports an extended series of experiments upon the thalami, made upon different classes of animals, with apparently very constant results. The conclusions to which his experiments lead him, briefly stated, are that the thalami play an important part in the expression of emotions; they are the motor centres through which the movements of expression are innervated, whether aroused by involuntary psychical impulses, as in disease, or reflexly by stimulation of the sensory nerves. When the cerebral hemispheres were removed, but the thalami left intact the animal of course could make no voluntary movements of expression, though such movements could be called forth by reflex stimulation. If the thalami were removed along with the cerebral hemispheres, movements of expression could not be obtained, either voluntarily or reflexly, unless the most painful stimuli were used. Direct stimulation of the thalami caused movements of different parts of the body, but especially of the face and ears, and the utterance of various cries. Finally, in an animal in which the thalami were destroyed without injury to the cerebral hemispheres, the power to make voluntary movements was not lost, but it seemed to be incapable of making its feelings or affections evident by the usual expressions of emotion; and when the sensory stimuli were not too strong these expressions could not be aroused reflexly as in the normal animal.

An extremely interesting contribution to the comparative physiology of the nervous system has been made by Steiner.[79] He finds that in the bony fishes the cerebrum may be completely removed, and yet the fishes have the power of making the most complicated voluntary movements, can capture their own food, give indications of the possession of a sense of taste, and of undoubted evidence of the possession of a visual sense, being able to distinguish colors, at least red and white. They are able also

to hold their own in competition with other uninjured fishes. These results have been confirmed, in part, at least by Vulpian, and show plainly that these functions which we have been accustomed to attribute without question to the cerebral hemispheres, must belong in the lower vertebrates to some portion of the brain lying farther posterior, probably the mid-brain. Post-mortem dissection proved that the cerebral hemispheres had been completely removed, and no regeneration had taken place. It must be remembered, however, in this connection that the cerebral hemispheres of the teleosts have for a cortex a single layer of epithelium, which can scarcely be regarded as nervous matter, This thin mantle or pallium of epithelial cells encloses a pair of basal ganglia corresponding to the corpora striata, which must have been removed in the experiments made by Steiner, though no loss of function seems to have resulted from their removal.

In connection with the general physiology of the central nervous system the experiments of Lombard[80] upon the "knee-jerk" or "tendon reflex" are of unusual interest. The experiments were directed not toward discovering the physiological explanation of this curious phenomenon, but in order to discover the variations to which it is normally subject. The results obtained are of direct value to the physician who uses this phenomenon to aid his diagnosis. They are in addition very suggestive to the physiologist as affording him an insight into the mode of action of the central nervous mechanism. With the aid of specially constructed apparatus Lombard was able to make his conditions constant; that is, he was able to graduate exactly the force of the blow which aroused the "knee-jerk," and moreover could register the extent of the movement of the foot. Perhaps the most interesting general outcome of the experiments is the fact that the "knee-jerk" is reinforced by almost any kind of activity of the central nervous system, showing that excitation of any portion of the brain or spinal cord affects to some extent the irritability of the whole mechanism. This can be explained most easily upon the supposition of the irradiation of the stimulus applied to any one group of cells or nerve centre to the remaining centres of the brain and cord. The education of the cord and brain has not been so complete that each stimulus flows only along the path desired: in

many cases there seems to be an overflow to other centres of the system. "Voluntary movements and strong emotions, when synchronous with the blow are found to increase the movement, and this is noticed even during sleep when the dreams are vivid. Similarly, sensory irritations, even when not strong enough to produce visible reflex actions, may markedly reinforce the knee-jerk." So general conditions which increase the activity of the central nervous system, such as rest, nourishment, invigorating weather, and wakefulness, increase the extent of the jerk; while fatigue, hunger, enervating weather, and sleep, conditions which depress the activity of the central nervous system, diminish the extent of the jerk. In accordance with this it was found that there is a well marked, if not perfectly regular, diurnal variation of the knee-jerk. More curious still, it was found that the "knee-jerk" showed definite variations with the thermometric and barometric changes of the atmosphere. In general, the jerk increased in extent with the rise of the barometer and decreased with the rise of temperature, and vice versa.

Semicircular Canals.—In a communication to the French Academy, Steiner[81] calls attention to some of his experiments upon the semicircular canals of sharks. He states that he was able to remove all the canals with their ampullæ from the internal ear of the shark without causing any noticeable disturbances in the movements of the animal. These experiments are the more interesting as they confirm the results obtained by Sewall in an exactly similar series of experiments made upon the same animal,—experiments which were published several years ago, though Steiner makes no mention of them. Sewall found also in the shark that disturbances of equilibrium were apparent only when the utriculus or sacculus of the animal was injured. Though even in this case the more neatly the operation was performed the less disturbance of equilibrium followed. The gross anatomy and histology of the semicircular canals of the shark are practically identical with those of man, and it is fair to assume that the organ has the same function in both cases. Since, according to the view of Delage, the semicircular canals are excited only by rotatory movements of the head, it may be supposed that in the shark, where this sort of movement is from the anatomy of the animal less prominent, the semicircular canals play a less important rôle in the maintenance

of equilibrium, and that, therefore, the results arising from their injury might escape notice.

Very interesting in this connection are the recent experiments of Ewald.[82] This writer points out that on the supposition that the semicircular canals have the same function with regard to body equilibrium in different animals we should expect different results to follow from their injury, inasmuch as the static conditions under which these animals exist are quite different. Experiments have shown that lesions of the canals have no perceptible effect upon fishes, a greater effect upon mammals, and the greatest effect upon birds. This condition was borne in mind in a number of comparative experiments upon different birds, made by Ewald. His operations were performed with the greatest care. In all cases the same canal—the external upon each side—was laid bare, a hole bored into it, and through this hole the membranous canal was cut by means of a special instrument. The results of this operation can be seen from the following table:—

DISTURBANCE.	FLYING.	SPRINGING.	HOPPING.	WALKING.	SWIMMING.	STANDING.
Very strong	Swallow.	....	.....	.....	.....	.....
Strong	Sparrow.	Crow.	.....	.....	.....	.....
Medium	Pigeon. Crow.	Sparrow.	Crow. Sparrow.	.....	.....	.....
Weak	Hen.	.....	.....	Crow. Pigeon. Hen.	.....	.....
None	Goose.	.....	.....	Goose.	Goose.	Crow. Hen. Sparrow Pigeon. Goose.

A study of this table shows that for any kind of movement, *e.g.*, flying, the disturbance caused in any bird is greater the more skillful and specialized this kind of movement is in this bird. The generalization to be derived from these experiments is that the disturbance in birds is greater the more difficult it is for the bird in the given form of movement to maintain its equilibrium, and the more complicated the coördination of muscular movements necessary to this end. This generalization may be extended to all classes of animals, and affords an explanation of the different degrees of disturbances produced by lesions of the canals which have been observed in different animals. A dog, for instance, sup-

ported upon four feet will show fewer disturbances than a bird with only two points of support, and so on. The experiments of Ewald at first sight seem to support the theory of Goltz, Brown, and others, that the semicircular canals are static sense organs for the preservation of body equilibrium.

SPECIAL SENSES.

It is generally believed that ordinary afferent or efferent impulses may irradiate in the nerve centres. Urbantschitsch[83] reports a number of observations upon the special senses which can be understood most easily by supposing that with this kind of sensory impulses also irradiation may take place. Auditory sensations, according to Urbantschitsch, are increased by light and diminished by darkness. Indeed, red and green light were found to increase the acuteness of hearing, while blue and yellow light dulled the acuteness. Musical tones were raised or lowered in pitch according to the color of the light falling into the eye. So taste, smell, touch, and temperature sensations were altered by simultaneous stimulation of the retina by different colored lights. The author concludes in fact that stimulation of any organ of special sense influences physiologically all the other special senses. He states also that subjective color sensations may be aroused by stimulation of the organs of the other special senses. In most of the men he experimented upon, subjective colors were seen upon looking at a white sheet of paper after the auditory, gustatory, olfactory or tactile organs had been stimulated.

Gelle[84] points out in the anatomy of the cochlea a mechanism which he thinks is of importance in the reception of sound waves. The cochlea may be considered as composed of two cones,—the scala vestibuli and the scala tympani, united at their apices by the helicotremma. Gelle studied the physical properties of a model constructed on this principle with regard to its advantages in receiving sound waves. He demonstrated that the intensity of the sound waves was increased in the first cone which received the waves, but suffered a strong diminution in passing through the narrow opening into the second cone. Accordingly the author supposes that in the structure of the cochlea we have a mechanism for intensifying the vibrations in the scala vestibuli, in which the membranous cochlea lies, and for diminishing the vibrations after

they have passed through the helicotremma into the scala tympani. In this way the function of the cochlea in perceiving the quality of musical sounds is aided, since the component vibrations of each tone are intensified.

Howell and Kastle[85] report a number of experiments upon a derivative of benzine, namely, para-brom-benzoic-sulphinide,—which fortunately exhibits the curious property of giving a sweet taste when placed upon the tip and the borders of the anterior half of the tongue, and an intensely bitter taste when placed upon the root of the tongue, that is, in the neighborhood of the circumvallate papillæ, or along the borders of the posterior half of the tongue. That a chemically pure substance can arouse different taste sensations upon different parts of the tongue is substantial evidence in favor of the doctrine of the specific energy of the nerves of taste, that is, that the primary taste sensations are mediated each by its own set of nerve fibres, and each gustatory fibre when stimulated if it responds at all, gives a taste sensation of only one kind. The evidence in this case is more acceptable since the two tastes produced by the sulphinide, sweet and bitter, are the two which are admitted on all sides to be primary taste sensations.

THYROID BODIES.

The function of these curious structures is almost entirely unknown. Several series of experiments made upon them, mainly in the direction of excision of one or both of the bodies, and observation of the resulting phenomena, have led to very uniform results, but the interpretation of these results is not at present possible. Ewald[86] has been working at the subject during the past year. His results are very interesting, but difficult to explain. His experiments were made upon dogs. In these animals the isthmus of the thyroids is wanting, the two thyroids being entirely independent of each other. Extirpation of both thyroids is followed by disturbances, ending in death, which have been carefully described before by Schiff. According to Ewald, the most marked effect is periodic tetanic contractions of the temporal muscles, and also the muscles of the shoulders. The muscles of the tongue show peculiar vermiform or fibrillar contractions, and the animal gives off a disagreeable odor in his expired air. The general behavior of the animal is very striking. Usually it falls into a condition

of apathy of an almost hypnotic character, cannot be forced or coaxed to make the quick, lively movements of normal dogs, and when placed in uncomfortable positions will remain there for some time. From this condition he can be aroused temporarily by making him run briskly for some distance. The recovery, however, is very brief: the animal soon sinks back into his previous condition of lethargy. Schiff found that if an interval of 25 to 35 days was allowed between the extirpation of the bodies of the two sides, the animal might survive the operation. He further states that if the two thyroids of one dog were transplanted to the abdominal cavity of a second dog, then the thyroids properly belonging to the second dog could be extirpated without causing death. From these and other facts he concluded that the thyroids manufacture a material which is necessary to the nourishment of the central nervous system; but that this material may be formed in other organs of the body, provided these organs are given time to assume their new function. With regard to the first of the two statements quoted from Schiff, Ewald's experiments gave a contrary result. In one case 39 days and in another 50 days were allowed to intervene between the removal of the two thyroids, but in each case death followed the operation. One very interesting result obtained by Ewald was, that if an extract of the thyroids was made and then injected subcutaneously into another dog, frequently this second dog showed the same condition of apathy exhibited by dogs from which the bodies were removed. The condition came on in about 3 hours after the injection and soon passed away. Ewald concludes like Schiff that something is contained in the thyroids which is of essential importance to the central nervous system; but whether it is something secreted by the gland, or, more probably, something formed in other parts of the body which is worked over and altered by the gland, remains undecided.

Similar experiments upon the extirpation of these bodies by Rogowitsch[87] gave him about the same results: the animals soon died with peculiar muscular cramps. Examination of the blood showed no change in the number of the corpuscles or in the ratio of white to the red corpuscles. In one animal the spleen was first removed and afterward the two thyroids, but the animal died as in removal of the thyroids alone. The thyroids, according to these results, seem to have no connection with the manufacture or de-

struction of red corpuscles, and no compensatory function with reference to the spleen. Transfusion of the blood of a dog in whom the thyroids had been removed into the vessels of another dog had no particular effect upon the latter. In one respect the author thinks that he has made an actual addition to our knowledge of this body. He finds that extirpation is followed by encephalomyelitis parenchymatosa subacuta. This manifests itself as a strong infiltration of the nervous tissue with round cells, granular cells, etc., in a swelling of the axis-cylinders, nerve cells and the protoplasmic processes from them, and in a change of, and finally complete disappearance of nerve cells in many parts of the brain. Like Ewald, he concludes that the peculiar function of the thyroids is to remove from the body certain, as yet unknown, products which are injurious to the central nervous system.

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GROWTH AND AGE.

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Our subject may be divided as follows: (1) growth of the tissues; (2) growth of organs; (3) growth of animals, including man; (4) diseases of growth; (5) longevity; (6) senility. The progress of knowledge has been very slight during the past year in all divisions of the subject of growth. The meagre attention paid to this branch of biology is somewhat difficult to explain, but it itself explains the shortness of this chapter.

GROWTH OF TISSUES.

Merk[1] has published a further elaboration of his previous observations[2] on the growth of the central nervous system in the embryo. Altmann, in 1881, first pointed out that the figures of nuclear division in parts of the central nervous system of the embryo are found next the central canal, and that therefore the pericentral stratum is the growing layer. These observations have since been confirmed and extended by Uskoff,[3] Rauber[4] and Merk.[2] In his last paper,[1] Merk points out that there is much greater variety in the distribution of karyokinetic figures in the medullary canal than appeared from previous researches, and that each region has its characteristics. Thus in the retina the growing layer is external or next the mesoderm; in the corpus striatum and thalamus opticus the proliferation takes place through the whole thickness of the wall, etc. Special stress is laid upon the difference between cell multiplication, which does not necessarily mean synchronous increase of substance, and cell growth, which does mean increase of substance. The growth of the nervous system depends chiefly on the enlargement of the cells, as Eichhorst[5] and Boll[6] maintained long ago, and it is incorrect to follow the custom of using the terms proliferation and growth as synonymous.

As regards the growth of nerves, there has been an important

step forward in the final and definite settlement of the fact that the nerves grow forth from the ganglion. Hensen[7] has suggested that the nerve fibres have from the start their permanent connections, and that as the cells of the embryo divide and move apart, the nerve fibres divide and lengthen out. Altmann,[8] however, has since shown that the fibres seen in the middle germ layer, mesoderm, are not nervous, but merely processes of the mesodermal or embryonic connective tissue cells. Kölliker,[9] too, pointed out that in the tail of the tadpole the number of nerve fibres and of the branches and anastomoses thereof, increases with the age of the animal, being at first very few in number,—so few that it is evident that the innervation of most parts must be developed later, there not being at first branches enough to supply all the terminal organs, which are ultimately furnished with nerves. During the past year, W. His, in a series of important memoirs,[10] has shown that the spinal and cerebral nerves grow forth from the main or central parts as massive trunks with abrupt ends. *Each nerve grows in a straight line* until it meets an obstacle, by which it is deflected or divided. The nerve or its branches, as the case may be, then grows on in new directions, but still as straight as before until another obstacle is encountered. Usually the obstacles such as a cavity, or condensed tissue (*e.g.*, cartilage producing), cause the nerve to fork. Thus the olfactory nerve grows straight down until it strikes the nasal cavity, when it divides, one branch going on the median and the other on the lateral side of the cavity.

The peculiarity of the nerves of growing in straight lines accounts in part for the distribution of the nerves in the amniota, the embryos of which are coiled up. The paths of the nerves, as they leave the medullary canal, are not parallel but convergent. Thus it is that the distal ends of the trigeminus and facial nerves approach one another in the early stages of human development, and ultimately in part cross one another's paths. When the connection of the nerve with its terminal organs is once established it is permanently maintained, so that when development progresses and the embryonic disposition of parts is shifted, the course of nerves becomes irregular; but the connections themselves are originally established as the result of the growth of the nerves in straight lines.

Samuel[11] has studied the influence of the circulation on the

growth of tissues. When the large wing feathers of pigeons are pulled out, new ones grow in their stead. If the veins of the wing are tied, there follows stasis; if the new feathers are not started, their development is impeded; but if their growth has already begun, there is no essential change in the rate of growth. If all the arteries are tied, growth stops entirely, of course. If one is tied, then the growth is greatly delayed, and the new feather dwarfed, unless, indeed, the growth is nearly completed, when the artificial anæmia produces little effect. On the other hand, if the vessels are kept dilated (by cutting the nerves of the wing), there is hypertrophy. In all these disturbances the healthy side takes part, though in a less degree,—just the opposite of what occurs with the kidneys, lesions of one of which causes the hypertrophy of the other. Samuel's experiments also indicate that disturbances of the circulation affect most readily the initiation of growth,—awakening of the histogenetic energy, as Samuel calls it,—next the processes of growth, and least readily the nutrition of completely developed parts. These suggestions open a wide perspective.

Fischer has published his memoir on the tendency of tissues to spiral growths. He attempts to demonstrate more thoroughly the doctrine, which he advanced some time ago, that all organs during their growth, assume a spiral shape, and that the spiral curves take a definite direction right or left, according to their anatomical relations to the central axis. As illustrations of spiral growth, he directs attention to the structure of the umbilical cord, the heart, the long bones, the bladder and the nerves; also to the segmenting ovum, and to the protoplasm in the individual cell.

Landsberger[12] followed the growth of 104 school-children, Germans and Poles, at Posen during the school years, 6–12, making twenty-five measurements on each child, once a year, but omitting the weight. During this period the spread of the arms remains approximately equal to the stature. While the body increases from birth to maturity $3\frac{1}{3}$ to $3\frac{1}{2}$ times in stature, the leg increases during the same period $4\frac{1}{2}$ times in length: this relative excess of increase of the leg depends chiefly on the elongation of the thigh. The circumference of the body at the navel makes a diminishing fraction of the stature,—0.489 at 6 years, 0.434 at 13 years. The head grows in all its measures much slower than

the body. From the 6th to 13th year the transverse diameter of the skull changes only from 14.5 to 14.6 cm., and may be said, therefore, not to change at all. Nor does the distance from chin to bregma change much; but on the other hand the distance from the chin to the line of hair on the forehead, *i. e.*, the height of the face, increases more than any other cephalic dimension, viz., from 13.5 cm. at six to 15.0 at 12 years. There are many other details. The section on the stature contains some criticisms on Bowditch, which are not valuable. Malling Hansen's work[13] contains the results of painstaking investigations. Cordeiro's paper[14] brings nothing new, either of observation or conclusion.

DISEASES OF GROWTH.

The diseases of growth may be classed under two heads, (1) actual deformities of growth; (2) symptomatic functional disturbances.

Deformities have been studied as yet very insufficiently, even those which fall within the province of the orthopædic surgeon. Nicalodoni[15] refers to a number of cases. In one, a child of 11 years, the ulna on one side was 6 cm. short, evidently the author states, on account of a separation of the ulnar epiphysis in the fifth year. Other cases are given, all of which indicate that interference with epiphyseal growth is not an unusual cause of deformity.

In regard to symptomatic maladies, Dauchez's paper[16] is important, and has been summarized as follows:[17] the condition which is commonly recognized in connection with accidents occurring during the period of rapid development, is an excessive development of the tissues, particularly the osseous tissues. This development is sometimes so rapid that there may be an increase of height of three to ten centimetres within a few weeks, and a tendency to ostitis, varying between simple pain and actual epiphyseal ostitis, at the femoral radial or humeral epiphysis, or even osteomyelitis in those who have reached adolescence.

Two symptomatic types of these conditions have been observed:—(1) the painful type, with headache, epiphyseal pains or neuralgia; (2) the febrile type, with remittent fever, which may be either acute or chronic in its course, and is always complicated by periods of pain. Such symptoms, when carefully followed up,

are likely to lead to the discovery of epiphyseal exostoses, whether femoral, tibial or peroneal, or cardiac hypertrophy without valvular lesion,—the disorder being neither rheumatic, syphilitic, nor paludal in character. Several cases are quoted in which more or less of the conditions referred to were discovered and could be regarded only as lesions associated with rapid growth. From these cases it is also concluded that the maximum frequency of these lesions is between the ages of 11 and 15, that is at the period of puberty; that the attacks of pain may be accompanied by irregular paroxysms of remittent fever or by paroxysms of intense fever, headache, delirium, and general symptoms necessitating a careful examination of the joints or the viscera, and that the morbid condition may continue six months to four years. In the table of cases narrated the cause of the extraordinary growth was, in almost all of them, violent exercise. The type of the morbid condition was the painful rather than the febrile.

LONGEVITY.

The past year has brought the usual supply of essays to prove that hygienic measures and good hereditary constitutions are favorable to longevity, and the usual supply of stories of extreme longevity. It need hardly be said that these publications have added nothing valuable to our knowledge.

SENILITY.

Professor Humphrey's papers on old age are thoroughly valuable. The first[18] continues the account of the post-mortem examinations of centenarians. One of the most interesting features in advancing age is the lessening size and weight of the cell-multiplying and blood-producing organs, the spleen, the lymphatic glands and Reyer's glands coincidently with the lessening of the nutritive activity and therefore of the demand upon the blood factors. The thymus gland fades soon; its special contribution, whatever it be, to the blood-compound ceasing, it may be inferred, to be required a few years after birth. The lymphatic glands are large in youth, and are easily caused to inflame, to enlarge unduly, and to take on other morbid conditions. As age advances they become functionally and pathologically less active, and are at their mininum in the centenarian. The brain was found shrunken,

with widened cerebral fissures. This shrinking of the brain,—common in old people and observed also in persons wasted by long illnesses, in habitual drinkers and some others,—is to be associated with the inability to maintain active and strong bodily and mental exertion, which, as our tables show, is commonly first manifested by fatigue, by weakening of memory for recent events, and is further manifested by impairment of control over emotions, thoughts and impulses, as well as over bodily movements, and may go on to complete imbecility, with or without tremor or loss of muscular power,—the latter being usually first observed with regard to the urinary bladder. The thoracic viscera, heart and lungs, unlike the cerebral and abdominal viscera, show an increase in weight in old persons.

In another paper[19] Humphrey reports on the maladies of old people. His remarks are based upon the analysis derived from the accounts of 824 persons, which were given with few exceptions by medical men, and which were in reply to the inquiries of the Collective Investigation Committee of the British Medical Association. Of these 824 persons, there were 340 males and 282 females between 80 and 90, and 92 males and 110 females between 90 and 100.

It may be first observed that, with regard to *Diseases and Failures of Particular Organs*, the immunities were in favor of the women, amounting to 55 per cent. as compared with 35 per cent. in the case of the men. The affection of the urinary organs especially preponderate, as we might expect, in the men. They are, indeed, more than twice as frequent in the men as in the women, amounting to 42 per cent., whereas in the women they were only 20 per cent. In the women, brain affections are more frequent than in the men, being 16 per cent. to 7 per cent. But the failures in the heart and in the lungs are about equal in the two sexes. It is worthy of note that 85 per cent. of the whole number are reported to be free from any evidence of rheumatic affections of the hands.

Of the various maladies, bronchitis is the dominating one, and, superadded to debility, it is oftener than any other assigned as the cause of death. It is, indeed, including the common winter cough, a very frequent malady in the British climate at all times of life. With regard to the heart we do not get much evidence

of disease. Some irregularity or intermission of pulse was noted in about a fifth of the cases observed. A knotty condition of the arteries, indicative probably of calcareous degeneration, is reported in 12 per cent. The brain affections, and the recoveries from them in old people, are among the most remarkable of their maladies. We are all familiar with the fact that passing attacks of unconsciousness, whether they depend upon temporary congestion or mere suspension of cerebral activity, or other cause, are by no means uncommon, and leave often no permanent diminution of mental power. The impairment or loss of motor power in some part, as a limb, is of course a serious addition, inasmuch as it commonly indicates a lesion or decided failure in some locality of the brain,—probably of the same nature as we find in similar attacks in less advanced age; and a paralytic seizure not infrequently ends the long but not necessarily strange or eventful history. While considering this point we do not forget that in the aged person the brain is gradually and progressively shrinking, and the interspace between it and the skull caused by this shrinkage is being filled by fluid effusion in the subarachnoid or pia-mater tissue. In only 11 out of 340 returns of men between 80 and 90, and in only 1 of the 92 returns between 90 and 100, is prostatic disease said to have existed; 52 were troubled with rheumatism in some of its many forms, which include pains in the limbs, aching in the bones, etc., for which we suppose a remedy is not very easily to be found. The severe forms of malignant disease are rare. One man, above 80, had rapidly advancing sarcoma of the shoulder; 5 women, between 80 and 90, had cancer of the breast; 5 men and 1 woman had epithelioma; and 1 man and 1 woman had rodent ulcer. None of these maladies are mentioned in the men or women above 90.

In 4 per cent. only is the digestion said to have been bad. In 71 per cent. it is reported as good and in the remainder moderate. Very few were troubled with constipation. In 62 per cent. the appetite is reported to be good; and by far the greatest number are stated to be good sleepers. Instances confirmatory of the inference as to the reparative powers of the aged after fracture, wounds and ulcers, which were based upon the returns furnished in reply to Collective Investigation inquiries, and which have been already published, are constantly being confirmed. What is even

more remarkable than the healing power of the aged after local lesions, are the reparative powers evinced by them after illnesses, as shown by numerous examples of those between 80 and 100, and also by some of the centenarians which have been already published.

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TECHNOLOGY.

By W. P. MANTON, M.D., F.R.M.S.,

DETROIT.

THE ever increasing importance of the microscope as an aid to diagnosis in all departments of medicine and surgery, renders it imperative that the physician should, in a measure, keep himself informed in regard to the progress made in this branch of science, and, to as great extent as possible, familiarize himself with the latest and most approved instruments and accessories, the improved methods of work, and the most useful micro-reagents for hardening, staining, and differentiating tissues which he is likely to be called upon to subject to microscopical examination.

Every one who uses a microscope not infrequently encounters the phrase "tube-length," and the query arises, what is meant by "tube-length?" In the minds of most, if not all microscopists, this has been a vague, undefined something having reference to the tube of the instrument. In order to satisfy himself as to what the makers understood by the term, Prof. Gage, of Cornell University, obtained the exact measurements of the parts included in "tube-length," from the leading manufacturers of the world, and found that they varied from 146 to 254 mm.[1] For the benefit of those who use the microscope, it is desirable that some standard be adopted by all instrument makers and that this should be about 160 mm. There should also be a common understanding as to the *parts* included in the tube-length.

Another important proposition discussed by Gage[2] is the thickness of cover-glass for which unadjustable objectives are corrected. The thickness of the cover-glass, as well as "tube-length," have an important influence on the perfection of the microscopic image, and where there is no correction collar, it is essential that the thickness of the cover-glass, for which a given objective is corrected, should be known to the microscopist, in order that he may use, in mounting his objects, covers of known thickness. The

thickness of the glass is easily determined by Zeiss' "cover-glass measure," or the micrometer gauge, made by the Providence Tool Co.

An almost indispensable accessory to the modern microscope, is the substage condenser.[3] This has existed in some form or other for a period of years, but was not brought to any thing like perfection until Prof. Abbé invented the apparatus which now goes by his name. Recently, however, the Bausch & Lomb Optical Co., have brought out an instrument of this kind, which is simple in construction and yet supplies all the needful condensation and modification of light rays.

The necessity of a constant temperature apparatus in which the heat can be produced by other means than illuminating gas, has long been felt. Such an apparatus is absolutely essential to successful interstitial embedding in paraffin. For this purpose Borden[4] has devised a very ingenious and useful electrical apparatus, which is simple in construction and not liable to get out of order. The battery used is the ordinary gravity battery used in telegraphy. Three cells are used.

Of the many section cutters which have sprung into existence, two only may be mentioned,—although all the others are serviceable instruments. The first of these to which reference is made is the New Model Hand Microtome, manufactured by J. W. Queen & Co. The advantages possessed by this microtome are that it can be used either for embedding specimens for section cutting, or as in the case of most vegetable and many firm tissues, securely clamping them. When it is desired to imbed, the clamp is lowered by the screw, and the cap fitted in to protect it from the embedding material. The clamp will be found to be very effective, grasping the specimen evenly and firmly. The stage is of darkened glass, and the metal portions of brass finish. A micrometer screw is attached, thus allowing one to obtain sections of any desired thickness.[5]

Prof. Ryder, of the University of Pennsylvania, has invented, and Joseph Zentmayer manufactured, an automatic microtome, which bids fair to be the instrument of the future. The working parts are an oscillating lever, provided with a clamp at one end into which the paraffine-holders are adjusted, and at the other with a single handle. This lever rests upon trunnions on either side,

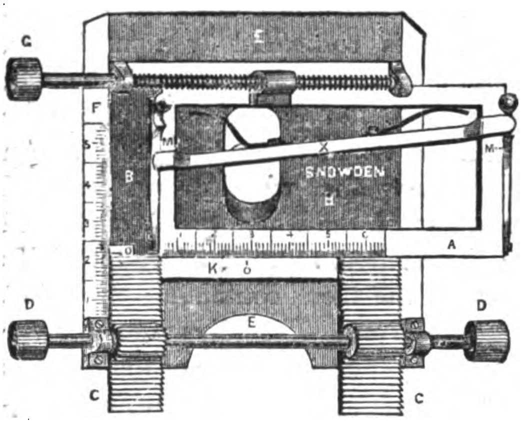
and these in turn, rest upon triangular notches at the top of the two pillars between which the lever oscillates. A spring pulls the cutting end of the lever down and effects the sectioning and also the adjustment for the next section. The lever is pushed over and adjusted for the successive sections by a hollow screw, through which passes the trunnion on the side away from the knife. This screw is fixed to a toothed wheel, three inches in diameter, which revolves close by the side of the oscillating lever. The toothed wheel and screw is actuated by a pawl fixed to the side of the lever near the handle. The number of teeth which this pawl can pass in a single vibration downward is controlled by a fixed stop, screwed into the under side of the oscillating lever near the handle; the end of this stop striking on the top of the bed plate brings the lever to rest at a constant point in its downward excursion. An adjustable sector by the side of the toothed wheel throws the pawl out of gear after a given radius of the wheel has been turned through an arc embracing the desired number of teeth. This adjustment is also effected before the block containing the object to be cut reaches the edge of the knife. The adjustment for the next section is, therefore, effected while the surface of the block is not in contact with the upper side of the knife, so that no flattening or scraping effect is produced on the surface of the block in its upward passage past the knife.

The movement of the vibrating lever being arrested at each down stroke at one point, and the pawl which catches into the notches.

A freezing-attachment, which has lately been appended to the apparatus, shows that frozen sections can be made with as great rapidity and success as those cut from objects embedded in the paraffine block, and very nearly, if not quite, as thin. It is as simple and efficient as the self-adjusting and cutting devices of the instrument. Other auxiliary apparatus makes it possible to cut cellodin sections. This is effected by means of alcohol conducted by a tube from a reservoir to the knife, over which the fluid will run and drain into a tray below in such a way as not to come in contact with any other parts of the machine. This tray fits into a recess in the side of the bed plate of the instrument just below the knife, and into this tray the celloidin sections may be allowed to drop as fast as cut.

The paraffine-holders are square and seven-tenths of an inch in diameter, so that a block of that size may very readily be sectioned. Almost any section knife, wide or narrow bladed, will fit into and be firmly held by the knife-clamp, which is, however, intended more especially to hold an ordinary razor. Only such razors as hold an edge well should be used.[6]

Dr. A. Smirnow,[7] of Kassan, has invented a useful mechanical stage and finder which he calls a microstat. The principle on which this instrument is based is the fact that any point may be determined by its distance from two fixed points or lines, on the same plane. The microstat is easily attached to any microscope. The chief point of excellence over the ordinary mechanical stage consists in the finder.



SMIRNOW'S MICROSTAT.—(*Arch. f. Mikr, Anat.*)

The objection to the metal section lifter—if one is confined to this old-fashioned method—is, that in handling fatty material the lifter soon becomes coated with a film which causes glycerine and water to run together in globules upon its surface. Dr. W. Y. Cowl[8] suggests, as a remedy for this, that the lifter be made of horn. This should be a flat piece, three inches long and five-eighths of an inch thick, the blade being smoothed down to about 1-200 of an inch thick. It is thus rendered flexible and can be insinuated beneath a section lying flat on the bottom of a dish. As horn contains fat, lifters used for water or glycerine must be made of burnt horn. The simplest lifter is a bit of paraffin, or cigarette paper. The section immersed in any fluid can be easily floated on to the paper, and thus removed from the medium. It is then placed on a slide with the paper topmost, and a slip of clean blotting paper gently pressed upon it to absorb superfluous fluid. The paraffine paper may then be carefully lifted off, and the object is ready for mounting. This is a much simpler and cleaner method than any lifter.

Prof. Eternod,[9] of Ghent, has contrived a very ingenious set of rings for stretching membranes previous to immersion in hardening fluids. The apparatus consists of slightly conical concentric rings of vulcanite, having a diameter of from 13 to 15 mm., which fit accurately one into the other, forming a nest. The membrane to be stretched is spread over one ring, while a smaller ring is introduced from below and crowded upward so as to fix the membrane and put it on the stretch. The rings and membrane may then be placed in a hardening or staining fluid.

Eternod has also arranged a turn-table, so that the body of the instrument may be used for several different purposes.

Krysinski[10] points out the fact that in order to obtain an intense red color in *alum carmine* staining, it is necessary to reduce the alum to the smallest amount possible (under 1 per cent.), to over saturate the solution with carmine, and to boil it one-half hour or more, whilst continually adding water.

SODIC-CARMINE.—Cuccati[11] has introduced a new sodic-carmine stain which is particularly suited for animal tissues. It acts intensely on the chromatin of the nucleus, and shows to good advantage the karyokinetic figures. For *in toto* staining, if the tissues have been hardened in alcohol, Kleinenberg's solution, or perchloride of mercury, the specimen must remain in the stain from five to twelve hours, according to its size. The staining should be done in a closed vessel, and the tissue should be washed in distilled water before decolorizing. The formula given for this preparation is as follows:—

℞ Warm water, ... 100 cc.
Carbonate of soda, ... 20 grms.
Mix and heat. Add
Powdered carmine (best), ... 5 grms.
Stir and cover. When the solution boils, cease heating and add
Absolute alcohol, ... 30 cc.
Allow the solution to cool in a partially closed vessel. Next day filter and add to the filtrate
Water (acidulated with 8 cc. of a 20 per ct. acetic acid), 300 cc.
Chloral hydrate, ... 2 grms.
For decolorizing a mixture of 100 cc. of spirits and 1 cc. hydrochloric acid is used.

CHLORAL-HYDRATE CARMINE.—Another carmine containing a large percentage of chloral hydrate is recommended by Kultschizky.

℞ Chloral hydrate, ... 10 grms.
Hydrochloric acid (2 per cent.), ... 100 cc.
Carmine powder, ... 1 grm.

Boil from one hour to one hour and a half. To prevent too much evaporation, cork the flask, and pass a glass tube through the cork. The solution should stand twenty-four hours and be filtered before using. The fluid gives a red stain that may be changed to violet color by immersing the sections in a two per cent. alum solution. By leaving out the hydrochloric acid, a neutral solution is obtained which is useful in double staining with Grenacher's alum carmine, or with picric acid.[12] Mayer[13] proposes this modification of the well-known Grenacher's carmine:—

MAYER'S-GRENACHER'S CARMINE.—

℞ Carmine,	4 grms.
Boiling water,	15 cc.
Hydrochloric acid,	30 gtt.
Alcohol (85 per cent.),	95 cc.

Neutralize the solution with ammonia.

LOWENTHAL'S[14] PICRO-CARMINE.—

℞ 1. Water,	100 cc.
Sodium hydroxide,	1 grm.
Carmine,	0.4 grm.

Dissolve the sodium in the water and add the carmine. This may be done cold in twenty-four hours; by aid of heat in 15 to 20 minutes. Filter. To the first solution add

℞ 2. Water,	100 cc. ther.
Picric acid (1 per cent. solution),	20–25 cc.

Allow the mixture to stand one hour and then filter two or three times.

INDIGO-CARMINE.—Krysinski[15] finds that a concentrated solution of indigo-carmine is almost instantaneous in its action upon animal tissues. It colors first the connective tissue fibrils, then the cement substance (Kittsubstance) later the cell protoplasm, and finally the cell nucleus. The color varies between a sky-blue and a light gray, and differentiates the tissue-elements well. Indigo-carmine is useful in double staining, especially with red and brown.

VICTORIA BLUE.—Lustgarten[16] recommends Victoria blue,—a product of the action of phenyl-naphtylamin on tetramenthldiamidobenzophenon, as especially worthy of note as a stain for elastic tissues and nuclei. Fresh preparations which have lain from 24 to 28 hours in Fleming's chrom-osmium-acetic acid, are thoroughly washed, and further hardened in alcohol. Sections of tissue thus prepared are placed in a solution of one to two parts concentrated alkaline solution of Victoria blue, and four parts water, and allowed to remain 24 hours. They are then rapidly washed (5 to 10 seconds) and dehydrated in absolute alcohol,

cleared in bergamot oil, and mounted in xylol balsam. The connective tissues and cells are stained pale green, the nucleus dark green, the elastic fibres blue green. Sections thus handled and kept in the dark will retain their color for at least six months.

In nucleus-staining a fresh, watery solution of Victoria blue should be used, and the sections allowed to remain in it for 24 hours.

METHYL-BLUE.—Arnstein's[17] experiments with methyl-blue in the living frog, show that if 1 cc. of the color is injected into the vena cava magna, the tongue and palate become stained at once, the dye remaining in the blood-vessels. In an hour or two the nervelets in the taste papillæ and the plexuses of the palate become blue; while the motor nerves become stained at a later period. Reichert's pleural muscle is used to determine the appearance of the stain. The first muscle is removed in two hours, and if not sufficiently colored, the second muscle is left for two hours longer. The eye muscles are treated in the same manner. The nerve staining is not permanent. Pal found that nerve fibres and nerve endings placed on a glass slip in a 20 per cent. solution of potassium iodide in glycerine and allowed to remain for several hours before covering, would retain the color for many weeks. The iodide, however, produces with the blue a precipitate of violet colored crystals, which color the nerves and mar the clearness of the picture.

Arnstein's[18] method is to inject through the blood circulation a one per cent. aqueous solution of iodide of potassium in iodine (dissolved to saturation). This turns the blue color to brown. The frog may be allowed to remain in the solution. The tissues to be examined are then removed and placed in the iodine solution for six to twelve hours, after which the iodine is removed by a thorough washing. The following day the nerves appear black, brown or gray, well defined against a colorless back-ground. The tissue must be mounted in acidulated glycerine. Methyl-blue has the advantage over gold chloride in only staining the cells and their prolongations, and not the lymph channels of the connective tissue corpuscles. Fat cells appear to have a great affinity for this stain.

THIOPHIN-GREEN.—Kraus[19] adds a valuable new stain to the list. This is a zinc salt of thiophin-green ($C_{21}H_{24}N_2OS$), and

is soluble in water, alcohol, oil of cloves and chloroform, the resulting solution having a beautiful green color, with a trace of blue. For double staining, the tissue should be thoroughly hardened, stained *in toto* in borax carmine, and then embedded in chloroform-paraffine and paraffine. The sections are fixed to the slide with collodion clove oil (1 to 3 or 4), the paraffine dissolved out in benzole, and the latter removed by absolute alcohol. A drop of a concentrated aqueous solution of the thiophin-green allowed to remain on the section for some minutes, then washed off in alcohol absolute, benzole, and mounted in benzole-dammar, gives the desired results; care must be taken with the washing, which must be thorough, or the nuclei will appear black instead of red. On the other hand, if washed too long the ground substance appears too pale.

Oxalic Acid.—Kühne thinks it advantageous to pass sections through a concentrated watery solution of oxalic acid and then thoroughly wash them before staining. He finds that watery solutions of the dyes answer best, and in the case of fuchsin, combines the stain with aniline or thymol water; methyl with a one per cent. watery solution of ammonia carbonate; violet with aniline or thymol plus ammonia carbonate.

Decolorizing.—Ciaccio and Campari[20] find a solution of hypochlorite of soda with excess of chlorine an excellent decolorizer of many animal tissues, as the retina, melanotic morbid products, etc. The specimens which have been hardened in alcohol or chromic acid are placed in a solution composed of eight (8) parts of caustic soda in one hundred (100) parts of distilled water through which chlorine has passed to saturation. The following action takes place, $2\ NAHO + 2\ Cl = H_2O + Na\,Cl + Na\,Cl\,O$, —the solution thus containing 7.45 per cent. of hypochlorite of soda. During the passage of the chlorine the solution should be surrounded by a mixture of salt and pounded ice, as, otherwise, the temperature rises and the product will be chloride and chlorate of soda. At first the solution has a green color, but light and time serve to pale it. The decolorizing action is in proportion to the greenness of the solution, and is due to the presence of chlorine, and also to the hypochlorite of soda, which acts by setting free nascent oxygen.

Fibrin.—Weigert[21] suggests a method of staining fibrin which

has the advantage of leaving all the other elements uncolored. The sections are first stained in a solution of gentian violet in aniline water. This is done in a watch-glass and requires but a short time. The section is then transferred to a slip, and treated with iodide of potassium, which is absorbed by bibulous paper, and then aniline oil is repeatedly dropped upon it. Before mounting in balsam, the oil must be thoroughly removed by xylol. It is best to mix the aniline oil with xylol in the proportions of two to one. Parasitic *fungi*, the micrococci of croupous pneumonia, tubercle and lepra bacilli are colored by this process, but the bacillus of typhus is not.

ELASTIC FIBRES.—Martinotti[22] has had good success in staining elastic fibres by the following method. The specimen is first hardened in a 0.2 per cent. solution of chromic acid. The sections are well washed in water, and placed for forty-eight hours in the solution of safranin.

℞	Safranin, ...	5 parts
	Alcohol, ...	100 "
	Let stand a few days and add	
	Water, ...	200 "

After staining, the sections are washed, dehydrated in alcohol, cleared in clove oil and mounted in balsam. The elastic fibres appear deep black with bright red nuclei, the rest of the specimen being colored a diffused red. The elastic fibres of the arterial walls are especially suited for this method.

VERNIX CASEOSA.—Strassman[23] in staining vernix caseosa, uses a drop of a one per cent. solution of gentian violet in a watch-glass of water. Sections or cover glass preparations, after staining five minutes, are washed in water and examined in oil. As the epidermal cells take the stain much more quickly than the surrounding structures, this is an important aid in determining the presence of vernix in cases of supposed intra-uterine suffocations.

SPERMATOZOA.—Ungar[24] determines the presence of spermatozoa in a suspected case (medico-legal) in the following manner: a small piece of cloth stained with the spermatic fluid is placed in a watch-glass of distilled water, to which a small quantity of hydrochloric acid has been added (one drop to one and one-third oz.); the acid prevents the spermatozoa from swelling up and breaking. According to the freshness of the stain, the cloth is allowed to soak from one to ten hours. The cloth is then

removed and stripped, the strippings and fluid being spread on a number of cover glasses, which are then dried by passing them three times through a flame. The preparations are now stained, and for this a double staining with eosin and hæmatoxylin has been found most satisfactory.

Eosin Solution:—

℞	Eosin, ...	38 grains.
	Rectified spirits, ...	1 ounce.
	Distilled water, ...	2½ "

The covers are allowed to remain in this one hour, are then removed, dried and washed in a mixture of one part alcohol and two parts water. They are then dipped into the hæmatoxylin solution, for which the formula of Friedlander or Böhmer may be used. To obtain a double stain the covers must remain sufficiently long in the solution—from a few minutes to a few hours. By this method the back part of the head of the spermatozoa are stained dark blue, the fore part of the head, the middle portion, tail and all other parts of the preparation, except cell nuclei (which take the blue) being stained red. The addition of a drop of acetic acid to the ounce of hæmatoxylin solution will prevent overstaining with that solution. It would be advisable, from ordinary experience in staining spermatozoa, to filter the first mixture of strippings and acid water through cotton to remove all extraneous matter, cells, etc., before spreading on the cover glasses. This is readily accomplished by stuffing a plug of cotton into the neck of a glass funnel so tight that the fluid can only run through drop by drop. This process will render permanent preparations more satisfactory, but for the purpose of diagnosis may be unnecessary.

Actinomyces Bovis et Hominis.—A Baranski[25] uses picrocarmine for staining fresh preparations of actinomyces bovis. A small amount of the contents of a yellow nodule or pus from the part is spread in a thin layer on a cover glass, and dried in the air. The cover is then passed three times through the flame, care being taken not to overheat the preparation. It is then floated in the picro-carmine solution, or a few drops of the stain are placed on the cover. In two or three minutes the staining is finished. The cover is then carefully washed by agitating it in water or alcohol, and examined in water or glycerine. The actinomyces takes a yellow color, while the remaining structure

appears red. In this way not only the actinomyces tufts are easily distinguished, but single nodes which are found scattered about in the preparation are sharply defined from the surrounding red mass. For permanent preparations, the cover glass should be dried before mounting in balsam. Sections of tissue are handled as usual, and are mounted either in glycerine or balsam. The micrococci found in chronic inflammations of the spermatic cord in horses are also colored by this method.

BLOOD.—Various methods have been suggested for the staining and preparing of blood. A method taught at Heidelberg[26] which gives beautiful results, is as follows: Allow fresh blood to fall drop by drop into a solution of osmic acid (two per cent. acid solution, one part; one per cent. solution sodium chloride, two parts; distilled water, one part). The solution should be constantly stirred while the blood is dropping. Allow the blood and acid to stand over night, and then wash the acid away with distilled water. Add alcohol, then clove oil, in which the blood may be kept indefinitely. Before the alcohol is added the nucleus of the corpuscle may be stained in alum-carmine, the blood afterwards being washed; or the whole corpuscle may be stained in anilin blue. Another method in vogue in Zurich[27] is much shorter, requiring but thirty-five minutes to complete the process. The following reagents are necessary, and the time allowed to each is stated:—

1.	Corrosive sublimate (concentrated solution),	6 min.
2.	Distilled water,	1 "
3.	Absolute alcohol,	5 "
4.	Distilled water,	1 "
5.	Hæmatoxylin (1–2 per cent. alum solution to which, for every 100 c. cm. employed, 20 drops 5 per cent. alcoholic solution have been added),	6 "
6.	Distilled water,	1 "
7.	Nigrosin (1–2 per cent. water solution),	1 "
8.	Distilled water,	½ "
9.	Eosin (1 gr. eosin dissolved in 60 c. cm. alcohol; 140 c. cm. distilled water),	2 "
10.	Alcohol,	5 "
11.	Oil of cloves,	1–2 "
12.	Xylol,	
13.	Canada Balsam (diluted with Xylol until it flows readily).	

A drop of blood is spread upon a slip previously moistened by the breath, and the whole thrown into the sublimate solution for six minutes. The slide is then washed in water, partially dried by resting the edge on a blotting paper, placed in an alcohol bath for five minutes, and again washed in distilled water. The hæma-

toxylin is then dropped upon the slide, and removed again at the end of six minutes, by resting the edge of the slip as before, upon a blotter. The glass is again washed in distilled water, and the same process gone through with the nigrosin, and eosin, the first remaining on the slip one minute, the second two minutes. From the eosin the preparation is brought directly into alcohol, since the eosin is partly an alcoholic solution. After five minutes the slip is taken from the alcohol, held at an angle, and a few drops of fresh alcohol poured over it. If upon dropping oil of cloves on the preparation it should be dark upon a dark sleeve or other dark back-ground, we may remove the oil of cloves with a few drops of xylol. Having quickly cleaned the slip close up to the preparation, we place a drop of Canada balsam upon it, which must be allowed to spread out before the cover glass is lowered upon it.

Another method originated with Biondi.[28] The blood is allowed to fall into a two per cent. osmic acid solution, in the proportion of two drops of blood to five c. cm. of the acid. In order that the two fluids may be thoroughly mixed, the glass containing the acid should be kept in motion during the process. The fluid is then set aside, and the blood elements soon settle to the bottom; first the red cells descend, then the white corpuscles, and lastly the blood plaques. In this way, by means of a pipette, either layer may be removed tolerably free from other elements. The hardening may continue from one to twenty-four hours. This period finished, the glass is again agitated and four or five drops of the mixture removed from the pipette. These are allowed to fall into agar-agar, which has previously been dissolved, and kept in a fluid state at 35° to 37° C. A cast is then made as in the paraffin method, and the mass allowed to cool. Stiffening of the agar-agar jelly takes place in a few minutes, when the cast is placed entire or in small pieces, in 85° alcohol to further harden. In two or three days the mass will have the consistency of amyloid liver, and can then be placed between elder pith and cut in the microtome, or after the agar jelly has been hardened, the cast may be placed for a few days in bergamot oil, and then for one to two hours in paraffin melting at 45°. After this a paraffin cast may be made, and sections cut. The paraffin is removed by the usual methods. In order that the agar-agar jelly may be transparent enough for this method, two parts of the plant are placed to soak

for twenty hours in 100 parts of distilled water. It is then cooked over a sand bath until the agar is dissolved, and carbonate of soda added until the reaction is slightly alkaline. The cooking is continued by steam for another hour; the fluid is then to be placed in test tubes and kept from twelve to twenty-four hours at about 50° to 60° C. At the end of this time the agar solution has separated into two layers, the upper and clearer portion being that used for embedding. A still further clarifying is necessary. This is done by adding the white of an egg while the fluid is at 40° C., agitating the mixture at frequent intervals for ten minutes, and then cooking in steam for an hour, and filtering. The reaction is again tested, and if necessary the fluid is neutralized with carbonate of soda. A clear solution results which is admirably adapted for histological work. The agar jelly should be kept sterile up to the moment of using; this is accomplished in the usual manner.

The blood sections may be stained, washed, cleaned and mounted in balsam or dammar in the usual manner for cleaning. Xylol should be avoided, as it produces rolling of the sections. The decolorization by means of iodine or anilin oil, according to the method of Weigert for determining the presence of fibrin, is of practical application here.

Embedding.—Much has been written in regard to the uses of celloidin, but no new methods have been suggested. Undoubtedly the failures reported with the use of this material are due to want of care in the preparation of the object. Properly hardened, the specimen is placed for twenty-four hours in a mixture of equal parts of absolute alcohol and ether, and then transferred to a very thin solution of celloidin for another twenty-four hours. After this it is placed in a solution of celloidin of the consistency of molasses, where it may remain indefinitely. It must be borne in mind, however, that celloidin has an advantage over paraffine only where the object has a loose mesh or cannot bear heat.

Photoxylin is a new embedding material suggested by Krysinski,[29] who considers it superior to celloidin in that it keeps indefinitely without deteriorating, and in solution or hardened mass remains clear. Photoxylin is a kind of gun cotton used by photographers and is quite soluble in equal parts of ether and absolute alcohol. For histological work two solutions are necessary, a thin solution, about one half to one per cent., and a thicker

of about five per cent. The tissue is taken from strong alcohol and placed in the thin solution from twelve to twenty-four hours, after which it is transferred to the thick solution. Moderate warmth hastens the infiltrating process. The specimen is taken from the solution with the forceps and placed on a cork, the amount of photoxylin adhering to the object being sufficient to secure it to the cork. As soon as a film has formed over the mass, it is placed in 70 per cent. alcohol, and in two or three hours is ready to cut. Sections may be stained and treated with any reagent and mounted in any medium. When balsam is used, oil of cloves should be avoided, and the thick erigeron oil substituted.

Celloidin-Paraffine Embedding.—Kultschizky[30] claims that a combination of these two embedding materials possesses certain advantages which are wanting when either is used alone. The object is taken from spirits and placed for some hours in a mixture of equal parts of ether and alchohol. It is then removed to a solution of celloidin of any strength, in which it remains for twenty-four hours. From the celloidin the object is transferred to erigeron oil, then to a mixture of paraffin and erigeron oil heated to 40° C., and finally to melted paraffine. The time which the object remains in the erigeron oil, the paraffin solution, and the melted paraffin, must be determined by trial, as it depends on the characteristics of the embedded objects. Cutting is done without alcohol.

Vegetable Wax.—Francotti,[31] as the result of his investigations, concludes that vegetable wax is much inferior to paraffin as an embedding material. The method which he advises is to place the hardened and stained, or not, object in 94 per cent. spirit which is kept at 48° C, in a water bath. To this the wax is added gradually in small pieces until the mixture has acquired the consistency of soap. If the object is small, the heat is evaporated until all the alcohol is driven off. If large, the alcoholic mass containing the object is poured into a bulb fitted with a straight cooler or tube about three feet long; as the spirit condenses it falls back into the bulb. When the object is properly saturated, it is removed to another vessel and the alcohol evaporated. The object is then oriented in a metal or card-board box filled with warm wax.

The sections are fixed to the side with albumen or gum. The slide is then heated in a water bath at 50° C. and alcohol added until the wax is dissolved. If not previously colored *in toto*,

the sections may now be stained, dehydrated, cleared in clove, cedar or bergamot oil, or mounted in glycerine. The advantages claimed for this medium over paraffin are that it dispenses with such fluids as toluol, xylol and chloroform, and is consequently suitable for animal tissues where these fluids are contra-indicated. It is useful also for the examination of tissues containing micro-organisms; here paraffin very often entirely obscures the microbes. The chief objections to the use of this material are, that it is difficult to obtain sections thinner than 0.01 mm., and to make out when the object is properly saturated.

Orienting Small Objects.—A simple modification of the well-known tubes of Selenka[32] may be made of an ordinary flat medicine bottle. This is fitted with a cork through which two tubes pass, or if the mouth is small, one tube may be fastened into a hole drilled into the bottle. One of these tubes is connected with hot and cold water, the other is a discharge pipe for the water entering the bottle, by the other tube and raising or lowering its temperature as warm or cold water is allowed to flow in. In the smooth flat side of the bottle four pieces of glass rods or strips are cemented fast, so as to enclose a rectangular space, which forms a receptacle for the melted paraffin. The latter may be kept fluid by allowing hot water to flow into the bottle. Time for arranging the object is thus obtained and solidification of the mass can be produced at pleasure by changing from the hot to cold water.

Removing Paraffin from Sections.—For getting rid of the paraffin in sections, Strasser employs benzine or warm turpentine. The sections are placed in chloroform for a short time, then in 60 per cent. alcohol, and finally are transferred to a weak alcoholic stain.

Fixing Celloidin Sections.—For fixing sections embedded in celloidin to the slide, Summers[33] has pointed out that if the section is first placed in 95 per cent. alcohol for a minute or two, arranged on the slide, and submitted to the vapor of sulphuric ether, the celloidin is immediately softened, becomes transparent, and is fixed to the slide. It may afterwards be placed in 80 per cent. alcohol or even directly into 95 per cent. The sections may be stained on the slide.

Clearing Celloidin Sections.—Clearing sections infiltrated with celloidin is not altogether satisfactory with erigeron or berga-

mot oils, the best clarifying agent being carbolic acid. Weigert[34] recommends this mixture:—

℞ Xylol,	. . . .	3 parts.
Liquid carbolic acid,	. . . . . .	1 part.

In order to make the solution anhydrous, the bottom of the bottle should be covered by a two-finger-thick layer of Cupr. sulph. siccum and the mixture allowed to stand for a time. After clearing this mixture, the sections are placed on the glass slip, dried with blotting paper, and mounted in thick balsam. The method is adapted only for hæmatoxylin and carmine preparations.

Special Methods.—Sectioning injected lung.—The great difficulty of making sections of injected lung tissue is well known, the shrinkage from the subsequent hardening distorting the relations of parts to a considerable degree. To obviate this, Doherty[35] has devised the following method: The lung is injected *in situ* through the right ventricle, with a stiff, but freely flowing, carmine-gelatine mass (Carter's formula is good), care being taken to throw the mass in slowly and with a uniform pressure, and not to over distend the vessels either by injecting too rapidly or for too long a time, *i.e.*, throwing in too much color. When properly filled, the pulmonary arteries and veins are ligatured, the lungs removed from the body, and distended with 90 per cent. alcohol injected into the air cells through the trachea, which is afterwards to be closed with a clip or "bull-nose forceps." The lungs are then weighted with lead and placed in a quantity of 90 per cent. alcohol. In twenty-four hours they are taken out, the clip is removed from the trachea, and as much alcohol as possible is drained from the organs. After this, they are to be re-distended with 90 per cent. alcohol, and placed in a fresh quantity of spirits of that grade just as before. This process is to be repeated on the fifth and tenth days and at the end of a month the lungs will be found to be well hardened without being in the slightest degree collapsed. A piece cut from one of the lungs, preferably at the root, and cut transversely across a bronchus, transferred to a beaker half filled with methylated chloroform is then placed in a water bath and heated to 100° F. The vessel should be shaken occasionally to facilitate the saturation of the tissue with the chloroform. In half an hour small pieces of paraffin to about fifty per cent. are added and the lung kept in this mixture for one hour. It is then transferred to

a bath of pure paraffine, and kept for two hours at 3° F. above its melting point. The tissue will be thoroughly infiltrated with the paraffine and beautiful sections can be made without trouble with a hand microtome and a sharp razor. The sections are passed through three consecutive changes of warm temperature, and finally, mounted in balsam and benzole.

VACUOLES OF CALCIFORM CELLS.—Prof. Ranvier finds that perruthenic acid can be used to good advantage in studying these vacuoles. If for example, the retro-lingual membrane of the frog is first exposed to the vapor of osmic acid for ten to twelve hours, the calyciform cells appear as clear colorless circles. The membrane now submitted to the vapor of perruthenic acid becomes blackened, and the calyciform cells are the first to darken, the mucigen alone being colored, the vacuoles remaining pale.

PERMANENT PREPARATION OF TISSUE.—Oviatt[36] has found that tissues placed in a 36 to 40 per cent. solution of potassium hydrate, and afterwards in a saturated aqueous solution of potassium acetate are permanently preserved, and may be stained and permanently mounted in glycerine.

METHODS OF DETERMINING THE NUMBER OF TRICHINÆ IN A GIVEN QUANTITY OF MEAT.—Gage[37] proceeds as follows: A section of the diseased meat is placed between two cover glasses of known thickness, and the latter are then pressed firmly together, and when the meat is well flattened out, the entire thickness is measured. By subtracting the thickness of the covers, from this result, the thickness of the meat is determined. The sections may be from one to three-tenths mm. (1-250 to 1-80 inch) in thickness. The upper or eye lens of the ocular of the microscope is then removed, and a piece of paper, in which a small square opening has been made, is placed over the round opening of the diaphragm. The eye lens is then replaced, and by the aid of a stage micrometer, the value of one side of the square field is determined. The opening is made square as a matter of convenience, as it is much easier to determine the area of a square than that of a circle. The number of parasites in the field of the microscope are then counted, twenty or more fields being gone over in the same manner in order to get an average which will fairly represent the number of parasites in one field. The cubic contents of one field is then found by multiplying the thickness of the section by the number representing the

value of the sides of the square field. From this the number of parasites in an entire cubic centimeter is computed. Divide the number by the specific gravity of muscle (1.058), and the result will give the number of parasites in one grain of meat. From this the number in one kilogram may be obtained by simply adding three ciphers (multiplying by one thousand), or in one pound avoirdupois by multiplying by 453,593, the number of grains in a pound. This exceedingly ingenious method of obtaining the number of parasites will recommend itself to the microscopist and the physician.

PREPARING COCHLEA OF GUINEA PIG.—Dr. G. Schwalbe[38] employs a method for preparing the cochlea of the guinea pig, which might be used with advantage in preparations of the human cochlea. The fresh specimen is first placed for eight or ten hours in Flemming's solution, and after a thorough washing, is decalcified in a one per cent. hydrochloric acid, where it must remain for twenty-four hours. Another washing is given to free the specimen of the acid, and it is placed successively in absolute alcohol, xylol, xylol paraffine, and finally saturated in Spee's paraffine at 35° to 60° C. If the animal is killed with chloroform and allowed to hang with head downward for some hours, a perfectly natural injection of the cochlear vessels is obtained. To isolate the vessels, the following maceration-method is recommended. The cochlea filled with blood is decalcified in three per cent. hydrochloric acid, and is then kept in the same acid in an incubator at a temperature of 40°. In one or two days the sheath of the cochlea is so softened that the cochlea and its spiral expansion can be isolated from the basilar membrane, and the ductus cochlearis unwound from the expansion of the nerve. After separating the nerve and the duct the spiral vein can be seen with a low power, lying by the ganglion spirale, and beneath this the tractus spiralis glomerulorum winding around the nervus cochleæ.

MUCOUS MEMBRANES.—Ranvier[39] has employed a method for examining the mucous membrane of the retro-lingual sac of the edible grass frog, which will apply to all membranes of this class. The membrane is detached and stretched over the disk of Ranvier's moist chamber in such a way that its epithelial surface is turned upward. During the operation, desiccation of the tissue is avoided by sprinkling it with aqueous humor, blood-serum, or chloride of

sodium in 7-1000 solution. The membrane is maintained in a state of expansion by a ring of platinum, which is fixed on the disk of the moist chamber; the ring must be of a little larger diameter than that of the disk, in order that the membrane may be held between the two. The membrane is covered by a glass plate which is fixed with paraffine. In such a preparation the cells with vibratile cilia, sensory or glandular cells, striated muscular fibres, and nerve fibres and cells may be easily observed in the living state. The advantage of this method of holding the membrane extended is obvious; by simply removing the glass, reagents as desired may be added, and their action immediately noted.

NERVE TISSUES—NERVES IN THE LIVER.—The method of Mr. A. B. Macallum[40] for investigating the nerves of the liver consists in hardening the specimens in Ehrlichs' fluid, or for several days in a one-sixth to one-fifth per cent. solution of chromic acid, and then finishing the process in alcohol. Sections of the frozen material are placed in a five per cent. solution of formic acid for an hour, in a one per cent. solution of gold chloride for twenty minutes, finally washed in distilled water, and the gold chloride reduced in the dark with a ten per cent. solution of formic acid. To accomplish this reduction about thirty hours and a temperature of 20° C. is necessary. The sections acquire a deep red color, occasionally with a violet tinge. The chromation of the nuclei of the hepatic cells takes a deep blue tint, the caryoplasma light violet, while the cytoplasma appears as a mesh work having a pink or light carmine color. The nerve fibres stain deep violet, and the connective tissue of the interlobular spaces appear in a light, or sometimes deep red color. When chromic acid is used as a hardening agent, the addition of any organic acid at the same time (*e.g.*, acetic acid) seems to have the effect of robbing the nerve fibres of their selective capacity for gold. The sections may be cleared in oil of cloves, and mounted in balsam.

For staining the axis cylinder of nerve tissue hardened in bichromate of potassium, F. Tangl recommends a one per cent. solution of nigrosin, or a weak alcholic solution of fuchsin. In preparing medullated nerve fibres, Boveri[41] places the fresh specimen for four hours in a half per cent. solution of hyperosmic acid. This gives good results if the acid comes in actual contact with the nerve fibres; in practice the central fibres of a bundle are usually

but partially affected. It must also be remembered that osmic acid, as Macallum has pointed out, while useful in medullated nerve fibres, is of no value for demonstrating the finest non-medullated fibres. From the osmic acid Boveri washes the specimen in distilled water, and hardens it in ninety per cent. alcohol. For staining, a concentrated solution of acid fuchsin is used for twenty-four hours, after which the specimen is treated for the same length of time in absolute alcohol, before embedding in paraffin. In treating nerves with silver nitrate Boveri finds that the following conditions result:—

1. In nerve tissue placed in a one per cent. solution of silver nitrate, to which an equal volume of ten per cent. nitric acid is added, the silver reaction takes place, and the fibrillar structure of the axis cylinder is to a certain extent retained, so that a periaxial space does not arise as the result of shrinkage.

2. In well-hardened, freshly-teased nerves which have been exposed in a partly dried state to the vapors of osmic acid, and then treated with a dilute watery or alcoholic silver solution, the silver reaction occurs almost immediately. A mixture of equal parts of a one per cent. silver solution and a one per cent. osmic acid solution gives the same reaction with fresh tissues as the silver shows by itself, so that such a mixture is especially useful as a preservative, and for demonstrating the boundaries of cells.

MAMMALIAN TESTIS.—In preparing the mammalian testis C. Benda[42] hardens the specimen, according to Biondi, in Flemming's chrom-osmic-acetic acid (one per cent. chromic acid 7 vols., 2 per cent. osmic acid 2 vols., glacial acetic acid 0.3–0.5 gr.). Concentrated picric acid and sublimate also yield fair results. In staining, the sections remain twenty-four years at 40° C., in a concentrated solution of neutral acetic acid and oxide of copper, are then washed and darkly stained in an aqueous solution of hæmatoxylin. Decolorization is effected by very dilute hydrochloric acid (1-300–500). The acid is again neutralized in the copper solution, the sections becoming a light bluish green. Dehydration and mounting complete this rather laborious method. The results, however, are permanent.

TENDON-CELLS AND CELLS OF LOOSE SUBCUTANEOUS TISSUE.—According to Dogiel[43] very good specimens which retain their color for a long time without changing, are prepared from the tendon of

a rat's tail which has been soaked in Grenacher's alum carmine for two or three hours, or better for a week or more. As the results of this the tendon bundles swell up and become transparent, and the cells appear beautifully stained, the elastic fibres standing out very clearly. By placing the tendon in a saturated solution of potash or ammonia alum, and afterwards staining in Grenacher's carmine, alum logwood, hæmatoxylin, eosin, etc., these may be mounted in glycerine, or placed in alcohol, cleaned with clove oil, and mounted in dammar or balsam. For subcutaneous tissue, a piece free from fat should be taken from the inguinal region of a mammal, spread out, and stained. Picro-carmine and the glycerine give the best results in permanent preparations.

Photo-Micrography.—In the articles which have appeared on the subject of photo-micrography during the past year, the writer has been unable to find anything new on the subject of making negatives and handling prints. This department has therefore been devoted almost exclusively to the description of instruments and apparatus.

If, as has been asserted by Mercer,[44] photography owes so much to the microscope, the microscopist owes much to the camera for permanently recording observations for which pen and pencil are wholly inadequate. From the time of Scheele, photography has gradually undergone the evolutionary changes which have brought it to its present high degree of art, but perhaps no one discovery of modern times, has done more to further the practical working of photo-micrography than the introduction of the gelatino-bromide process, so that to-day the advances made in this line, as applied to medicine and surgery, may be considered as little less then remarkable. Nearly all departments of science have recognized the necessity of something decidedly more accurate than the most carefully executed drawings, which, however well done, convey more to the artist than to others, and however impartially carried out, tincture more or less of his own interpretations. The untouched photograph, however is never partial, shows the object as it actually is, portrays parts wholly beyond the executive ability of the most expert draughtsman, and requires no special talent or ability in its production; while the modern methods and the ease and facility with which photographs can be made, together with the comparative inexpensiveness of the outfit, renders the camera an almost indispensable adjunct to the physician's armamentarium.

In anatomy, surgery, medicine, obstetrics, histology, even diseases of the skin, and many other conditions to which it is applied, photography is rendering an immense service.

The argument has often been advanced that the expense of apparatus will prevent the photographic camera from coming into general use; but this objection can no longer be said of photomicrography, since Ch. Lecerf[45] has proved that a very good camera for this purpose can be had for the outlay of a few cents. This camera, according to the author's own words, is made of an ordinary wooden box from 10 to 12 cm. in length, and of sufficient size to admit the plate employed. It is well-stopped inside, and blackened, so that no light can enter. The sides of one end, the board of which has been removed, are grooved to admit a ground glass plate (focusing plate), while in the other end a hole is drilled, into which is fastened a piece of rubber tubing six cm. long, and of sufficient diameter to slip readily over the eye-piece of the microscope. Over this tubing a sleeve of black velvet is placed, and secured at each end by an ordinary rubber band. To use the camera, the object must first be brought into the field of the microscope, the tube of which is then bent at right angles to the foot, the eye-piece slipped into the rubber tube, and the velvet sleeve drawn over it, and fastened with the rubber band, so that all light is excluded. An ordinary petroleum lamp is then placed in front of the microscope, and by means of a magnifying glass it is determined whether the image on the glass plate is clear and distinct. Should this not be the case, the object is brought into focus by means of the micrometer screw. Thus arranged, the glass is removed and a holder containing a sensitive plate is slipped in its place, and the exposure made.

While we can hardly imagine very gratifying results from such an instrument, Lecerf claims that its achievements are very good. Another camera which combines efficiency with simplicity, is the Nelson-Curties.[46] This consists of a board with rubber feet of sufficient length to take the camera when fully extended, the microscope and the lamp. The camera consists of two square tubes of cardboard, one sliding into the other like a telescope,—the joint between the two being made light-tight by a velvet flap which is secured in place by a rubber band. The ends of the tube are of wood and upright, and slide in grooves in the base-board, being

fixed by thumb-screws. The front board has a brass nozzle to fit into the light-excluding cap on the microscope. The focusing screens of gray glass and plain glass with ruled lines, slide in grooves at the back of the upright piece of wood. The double back is that known as Tylar's patent metal. Focusing is effected by means of a rod which runs down the right side of the camera, a string passes around this and over a pulley on the other side of the board, taking a turn around the milled head of the fine adjustment screw.

A home-made camera and holder has been suggested by Field,[47] the chief objection to which (and this applies to a large number of contrivances in this line) is its bulk.

Crookshank[47] has devised a reversible photo-micrographic apparatus. This consists of a base-board 4 or 5 feet long to which the camera is fixed and the microscope is clamped. Illumination is obtained by an oxyhydrogen lantern which also rests upon the table. In order that organisms in liquids or cultures in gelatin may be photographed, the apparatus is arranged to be placed in a vertical position also.

Ellis[48] has arranged on the focusing rod of the camera a loose arm at the end of which is a roller covered with rubber, which is made to revolve by an endless strap which passes around a wheel upon the rod. The roller is kept in contact with the fine-adjustment screw of the microscope by means of a rubber band attached to the base-board and the arm. Nearly all focusing arrangements for photo-micrography, however, are defective and annoying, and it would seem that Crookshank's latest method is most desirable, in that it does away with focusing rod, strings and complicated mechanisms. Mr. E. M. Nelson,[49] of London, England, has devised a useful focusing screen, which has the inch and centimeter scales and a crossed diagonal scale engraved upon the glass. Not only does the engraving form a convenient spot on which to focus, but by means of the scale the magnifying power may be determined.

The question of the use of the eye-piece in photo-micrography is one which interests all engaged in this pursuit. The latest to take up the discussion of the subject is Rafter,[50] who asserts that the use of the eye piece causes not only great loss of light, but also great loss of distinctness in the image. His experience leads him

to the conclusion that the use of the simpler optical combination of the adjustable achromatic amplifier, is preferable to all so-called projecting eye pieces. Rafter's photo-micro camera is specially designed for doing photo-micrographic work of a high character with the greatest possible economy of time. It is for this purpose that the second prism-tube has been added specially for low power work without the amplifier, and Rafter has no difficulty in making with this camera a half dozen negatives in an evening, when working with lamp light and the amplifier, or from eight to ten in the same time when working with low powers and without the amplifier, in each case doing the developing himself. In working by sunlight, where much shorter exposures are required, the same length of time gives an additional amount of work.

In case one has an extra microscope, the new apparatus for working the amplifier may be adapted to it at moderate expense, and by construction of the bellows and extension arrangements as above described, the most important advantages of the camera gained.

One of the most satisfactory cameras for the physician, in the writer's opinion, however, is Walmsley's Improved Photo-Micro Camera; for not only is this instrument admirably adapted for photo-micrographic work, but with the addition of a Beck or Darlot portrait lens, the physician is also enabled to take admirable photographs of cases, etc., which occur in his practice, with the minimum of time and trouble expended.

An important feature of this camera is that it can be utilized in copying, enlarging, or reducing. This is effected by introducing any good rectilinear photographic lens into the middle division of the bellows, which is fitted with a stop-cam, the same as that used at the rear of the bellows. The front of the box is fitted with a double shifting arrangement, so that upon removing the cone, a negative of either size made by the camera can be inserted and accurately centered; then, by suitably manipulating the instrument an enlarged or reduced image may be cast upon the focusing screen.[51]

W. His[52] has invented an "Embryograph" for photographing serial sections, which will prove of great service to those engaged in this line of investigation.

But whichever camera is employed, the operator must bear in

mind that it is absolutely essential that the microscope lenses used shall be of excellent quality, possessing good definition, penetration and flatness of field. Miss King[53] states that the penetration may be improved by inserting a diaphragm behind the posterior combination of the objective at the point of greatest convergence of the rays. This point is most easily ascertained by sliding the diaphragm up and down until the proper spot is reached. For this class of work the apochromatic lenses of Zeiss, of Jena, and Gunlach, of Rochester, are meeting with great favor. Where apochromatic objectives are not used, the difference between the chemical and visual foci may be remedied by the use of a blue cell.

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HISTOLOGY.

By W. P. MANTON, M.D., F.R.M.S.,

DETROIT.

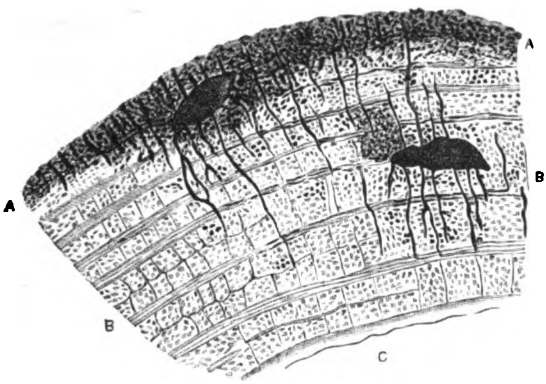
HISTOLOGICAL RESEARCH is now so largely devoted to animal (zoölogy) rather than human tissues, that the literature of the latter is not only widely scattered, but difficult of access. The work that has been done, however, is for the most part of practical interest, and a synopsis of the most important papers which have appeared will indicate the advancement made in this department of medicine.

The Glands of the Nasal Mucous Membrane.—Paulsen[1] has found that the glands of the osometric region in horses, calves, pigs, guinea pigs and goats, has a mixed epithelium, which is peculiar to the mucous and serous glands. Aside from these there is a third form in which the characteristics of the other two unite. In the glands of the respiratory region of man, only the mucous were found.

Structure of the Striated Muscular Fibres in Man.—Babinski[2] has found, in the striated muscular fibres of man, that in the connective tissue separating the bundles of fibres, there are numerous islets of a more or less regularly rounded form, and of the diameter of from two to three hundred micro-millimeters (about eight to twelve thousandths of an inch). These bodies are constituted as follow: At their surface is a sheath of connective tissue, which stains deeply red with picro-carmine, very distinct from adjacent structures, and resembling the lamellated sheaths of nerves. In the space defined by this sheath are to be seen a group of from three to seven striated fibres, inferior in size to the fibres of other parts of the muscle, but exhibiting a large number of nuclei. In some of the islets, nerve tubes as well as muscular fibres were found. The structures of some of these islets are moreover somewhat complicated, inasmuch as the sheath is sometimes divided into two or three secondary compartments by processes of con-

nective tissue; in one of these compartments small muscular fibres may be found; in a second, a nerve trunk; in a third, vessels. The small groups of fibres appear to be secondary bundles of muscle in course of degeneration, a (so to speak) physiological atrophy.

Nerves in the Liver.—Macallum's[3] researches in regard to the nerve terminations in the liver of man and necturus indicate that an intercellular nervous network exists, from which excessively fine twigs are given off, each terminating in a delicate bead, in the interior of the hepatic cells, near the nucleus. In the necturus the nerves also break up into very fine twigs, which enter the gland cells and branch, and terminate in beads or swellings near the



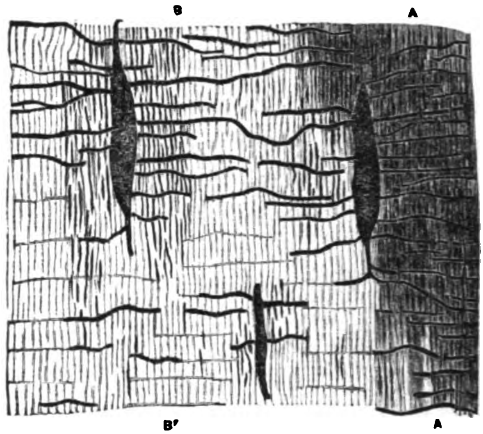
1. Transsection of Diaphysis of Femur which has been Digested for 12 Hours in Water in a Sealed Glass Tube at 120° Celsius.—A A, portion containing air. B B, partly cleared. In this portion dark points appearing singly and in groups indicate the transversely divided tubules which contained the fibrils; the short, dark lines are these tubules obliquely divided. C. Lumen of the Haversian Canal.—(*Archiv f. Mikrosk. Anat.*)

nucleus, which is in immediate contact with the protoplasmic reticulum within the cell.

Are Bone Fibres Calcified?—Ebner[4] reasserts the opinion already advanced by him that the fibres of bone tissue are not petrified, but that the lime salts are deposited in the cement between the fibrils. In a careful reply to Kölliker's criticism, a reconsideration of the subject is undertaken, and the above opinion substantiated. Various methods are given, but in a section of bone which has undergone a prolonged cooking in water, or has been burned, minute tubes which have held the fibrils may be seen.

Development of Elastic Tissue.—Kuskow's[6] investigations to determine the development of elastic tissue, while they indicate

that the cell-nucleus has a share in the formation of this tissue, do not prove that the latter arises originally in the nucleus, or is formed solely by it, since it is possible that the protoplasm participates in this. In the ligamentum nuchæ of a five months' calf embryo, the elastic fibres passed from the ends of the nucleus, arising in some instances in the interior of the latter, whence they could be traced to their exit. Aside from these, fibres are met with which go from the end of the nucleus, from a single portion of which from one to five fibres may be given off.

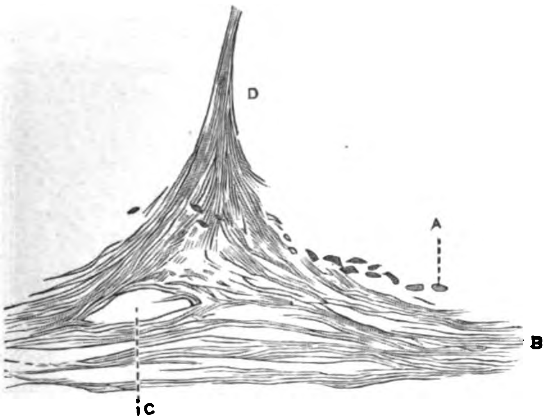


2. A A AND B B AS IN FIG. 1.—THE DARK LINES ARE THE FIBRIL-CONTAINING TUBULES.—(*Archiv f. Mikrosk. Anat.*)

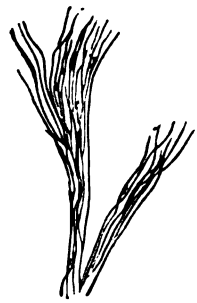
In the arytenoid cartilage of a two and a half months' calf, the existence of cells which would produce new elastic tissue could not be determined, but the connection between well developed elastic tissue and the cell-nucleus could be demonstrated.

Structure of Fallopian Tube.—Orthman[7] has studied the normal Fallopian tube, more especially with reference to pathological changes. The Fallopian tube-wall consists of three principal layers: a mucous, a muscular, and a connective tissue layer. The thickness of the entire wall at the uterine end is 0.3–0.4 cm.; at the abdominal end 0.9–1.2 cm. The relation of the three layers is quite different in the different portions of the tube: thus, while the mucous coat is thinnest in the uterine portion, the muscular layer forms the greater portion of the wall, and in this latter the external longitudinal layer is about twice as thick as the internal circular layer of fibres. This relation gradually changes, so that at the abdominal end the mucous membrane forms the bulk of the wall, while the muscle layer is considerably weaker. The most external layer of connective tissue remains about the same, except that toward the abdominal end it becomes somewhat looser and more vascular. On this layer is situated the flat layer-endothelium of the peritoneum.

Structure of Reticular Cartilage.—In R. Kolster's[8] studies on reticular cartilage he finds that the fibrillæ run parallel with the

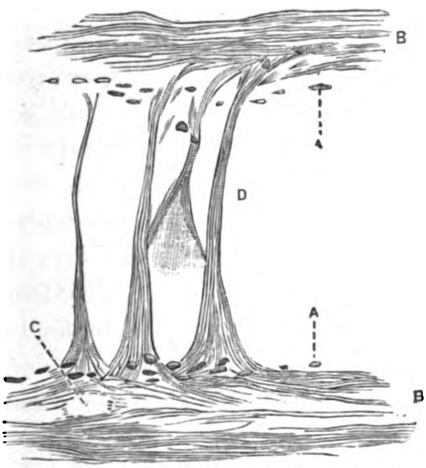


1. SECTION FROM VICINITY OF PERICHONDRIUM.—A, cells lying upon the perichondrium. B, perichondrium. C, blood-vessels. D, Broken-up intercellular substance.—(*Archiv f. Mikrosk. Anat.*)

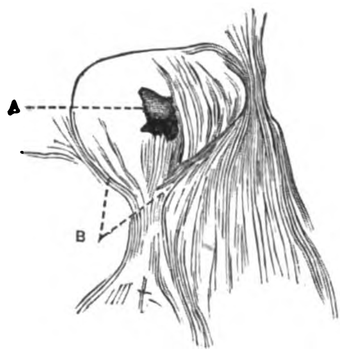


2. TEASED PREPARATION.—(*Ibid.*)

perichondrium for a distance, and then bending toward the middle assume a more vertical direction. If individual fibres are followed to the perichondrium, it will be seen that they run into the latter,



3. CARTILAGE FROM RIM OF EAR. Letters apply as in Fig. 1.—(*Ibid.*)



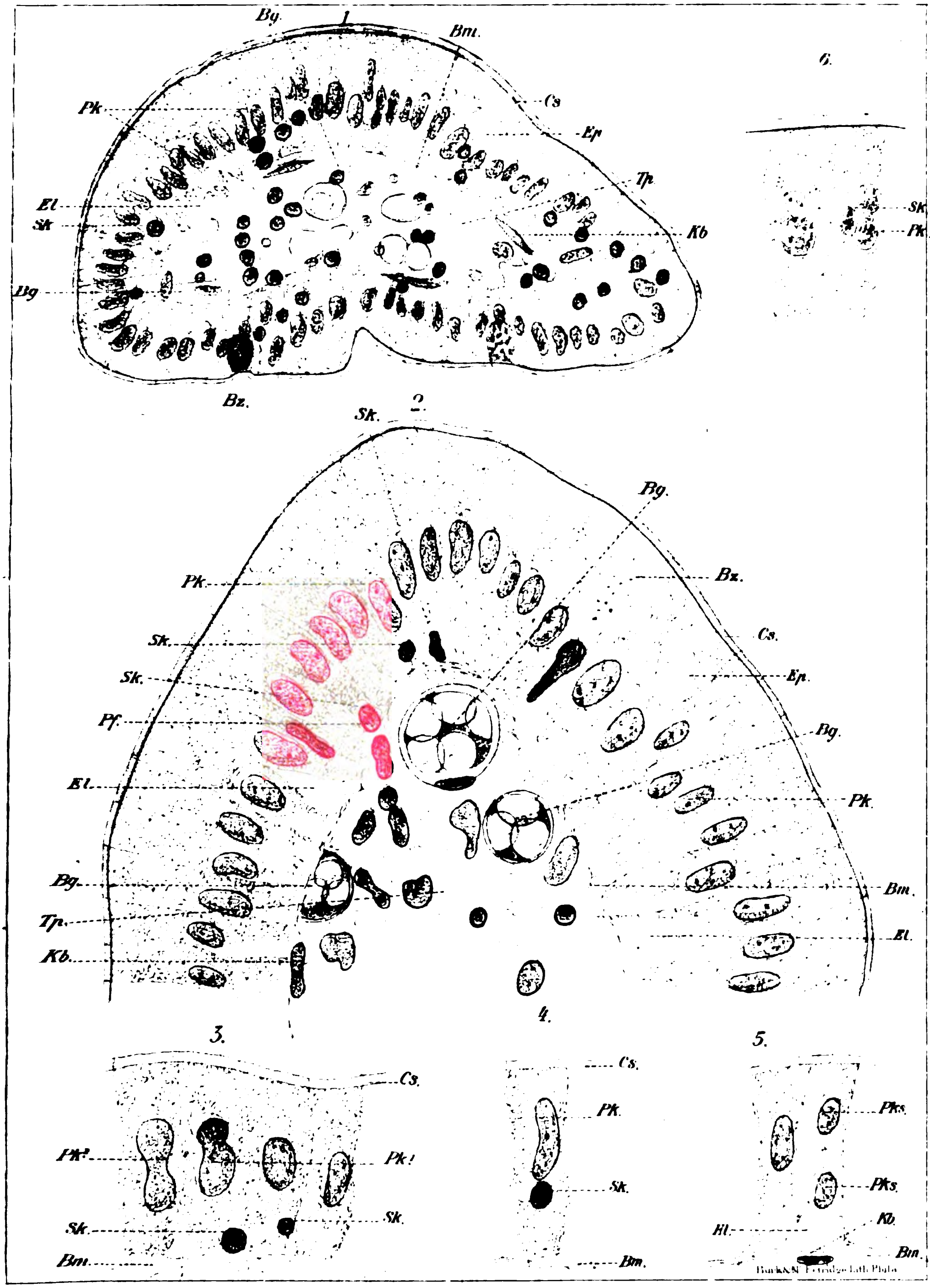
4. DETACHED CAPSULE. — A, a shrivelled cell. B, capsule membrane, fibrillated.—(*Ibid.*)

where they may be traced until they become indistinguishable from the connective tissue fibres of that membrane. In the mid-

dle of the cartilage, the fibres run perpendicular to the perichondrium and are more or less united in bundles. This is best seen in sections taken from the lower portions of the ear cartilage, where the intercellular substance appears as a net of fibre bundles, in the meshes of which are found the cells. Contrary to the teachings of modern text-books, Kolster finds that it is impossible to differentiate the delicate "membrane" capsule as an independent structure. In sections in which the capsule is half preserved a ring is seen, part of which is raveled out as fine fibrils. (Fig. 4.) Neither teased preparations nor portions spread as a film between the cover and glass slip show the branching fibrils, as found by Tillman in the knee-joint cartilage, but denied by Kassowitz, nor are there plasmatic channels, as pointed out by Hertwig.[8]

5. INTERCELLULAR SUBSTANCE FROM EAR BROKEN UP INTO FIBRILS.—(*Archiv f. Mikrosk. Anat.*)

The Relation of the Intestinal Epithelium to Lymphoid Tissue.—The studies of Davidoff[9] on the relation of the intestinal epithelium to the lymphoid tissue present the subject in a different aspect than that of other authors, and opens anew the discussion of this much mooted point. In the epithelial lining the cells are broadened toward their free ends, but become contracted and even pointed at the so-called basement membrane. In places they divide, leaving more or less space between the two processes. From these basal extremities of the cells fine processes go off into the basement membrane (fig. 3 and figs. 4–10), and from this latter other fine threadlike processes go to the connective tissue below, so that no division line is to be found. This leads to the conclusion that the basement membrane is a middle zone belonging to, and made up of processes from both the epithelial and adenoid substance. This theory is opposed to the writings of Donitz, Eberth, Kölliker and others, who hold that the basal membrane is made up of closely approximated, fine connective tissue fibres; to those of Quain, Watney, Drasch and Ranvier, who think the basal membrane is an endothelial tunic having lacunæ, etc.

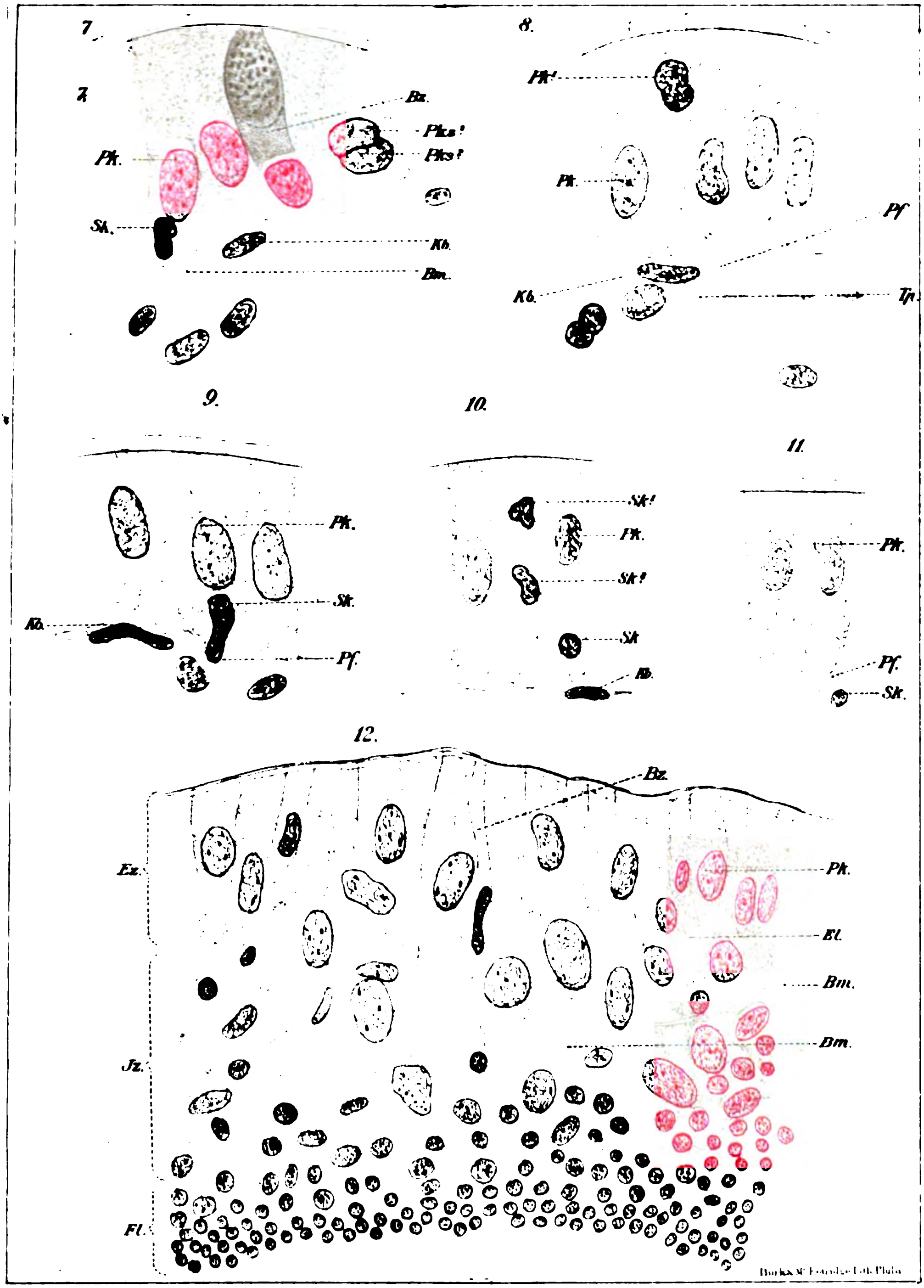


The Relation of Intestinal Epithelium to Lymphoid Tissue [illegible]

From Archiv für Mikrosk. Anat. [illegible] Bonn.

Explanation of Plates I, II & III. [illegible]

Fig. 1 Transsection of human jejunum. Fig. 2 [illegible] of a fold of same. Fig. 3 [illegible] thelial cells from human jejunum with [illegible] in Fig. 4 [illegible] processes [illegible] Fig. 5 [illegible] the epithelial nuclei to leucocyte nuclei. Fig. 6 [illegible] 17 Epithelial cell from the cell wall of a crypt.



The Relation of Intestinal Epithelium to Lymphoid Tissue [illegible]

From Archiv für Mikrosk. Anatomie [illegible] — Max [illegible]

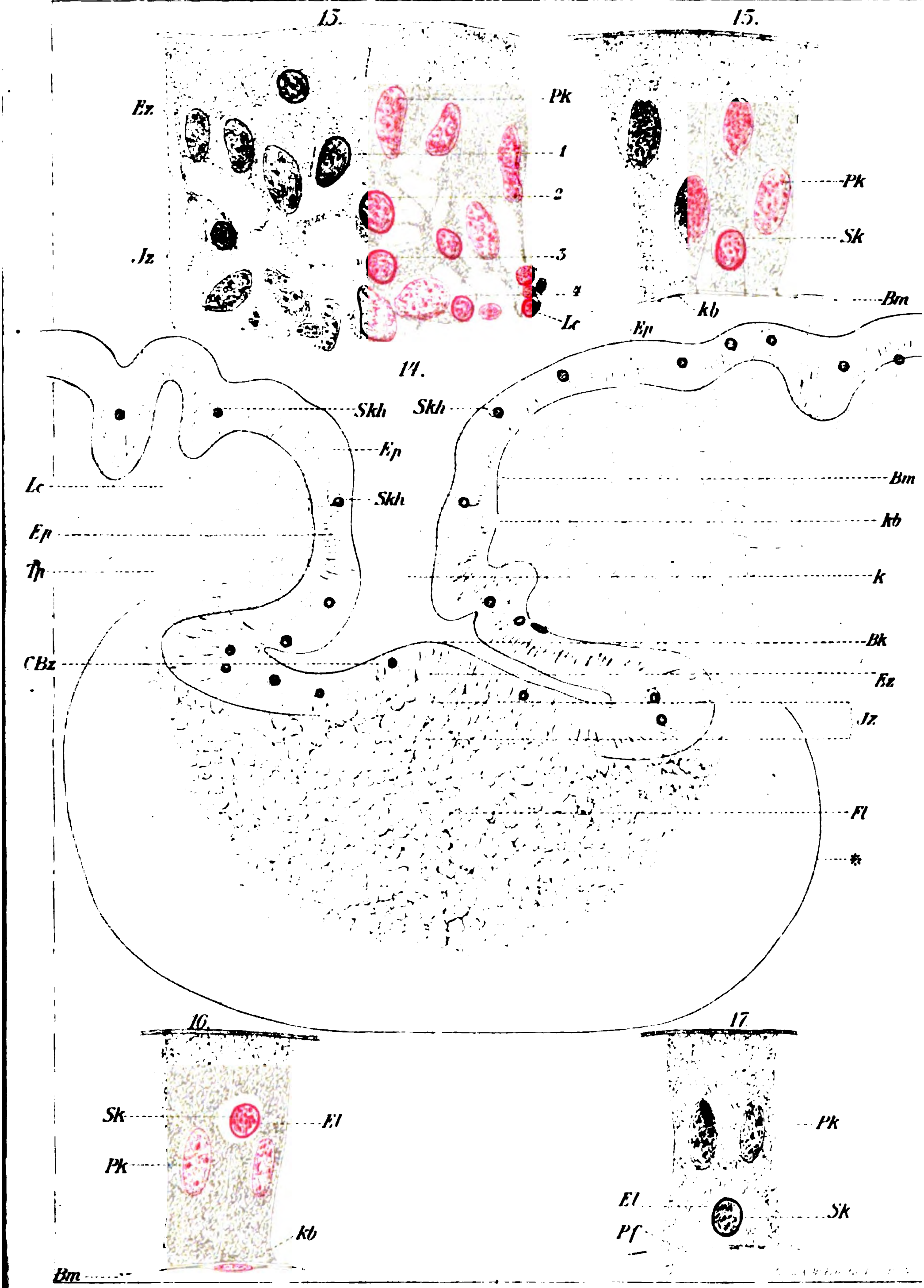
Explanation of Plates I II & III (The letters are the same for all the drawings [illegible])

[illegible] Pk. Primary nucleus [illegible]

Bm. Basement membrane [illegible]

Bz. Goblet cell [illegible] Fl. Lymph follicle. Kb. Nuclei [illegible]

the basement membrane [illegible] Pf. [illegible] processes of the epithelium



The Relation of Intestinal Epithelium to Lymphoid Tissue [illegible]

From Archiv für Mikr. Anat. [illegible]

Explanation of Plates III & IV. The letters have the same [illegible]

Cs. Cuticular Border. Ep. Epithelium. Pk. Primary nucleus. Sk. Secondary nucleus. Bm. Basement membrane. Tp. Tunica propria. B. Blood vessel. A. Adenoid tissue. Lc. Leu[illegible] Bz. Goblet cells. Ez. Epithelial zone. Iz. Intermediate zone. Fl. Lymph-follicle. Kb. Nucleus of the basement membrane. El. Epithelial lacunae. Pf. Protoplasmic processes of the epithelium.

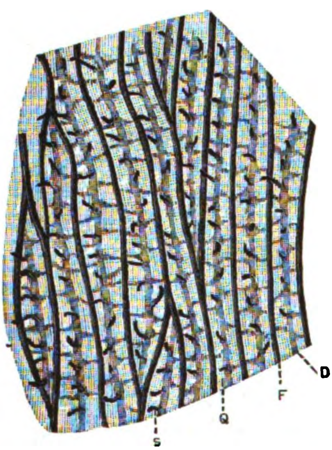
The fact that nuclei are met with in this middle zone disproves its endothelial nature. These nuclei are not regular in their arrangement and are found in the thickest portions of the basal membrane, and probably belong to the epithelial (fig. 1) processes.

The lining epithelium has two nuclei, a primary and a secondary. The latter may not be constant, being connected with the digestive process. The primary nucleus is generally situated in the middle of the cell, frequently in its basal third, and rarely near its border. It has a cell membrane and a varying number of nucleoli. (See colored plate, Figs. 1–11 Pk.) The form of the primary nucleus is elliptical; it is usually twice as large as the secondary nucleus, and as a result of a lesser condensation of the chromatin, the entire nucleus appears more transparent. The chromatin of the secondary nucleus is condensed, and the nucleus membrane is quite firm. It is generally round and varies in number, there seldom being two in one cell. (See colored plate, Figs. 1–6 Sk.) This secondary nucleus is rarely seen between the free-border of the cell and the primary nucleus, and is never found in the border itself, or in the flask-shaped crypts or lymph-ganglions. The origin of these nuclei is uncertain. It is disputable whether they are wandering leucocytes, and it is not positively settled that they are the result of nucleus division or budding. The future of these cells is also problematic. They are not constant in the epithelium, disappearing entirely. It is hardly likely that they break up in the cell, but are probably eliminated. This may be accomplished in two ways; either they are cast off into the intestinal lumen, or they are passed into the stratum proprium; the latter is altogether probable. As the layer of leucocytes below the middle zone have nuclei, which in size and shape cannot be distinguished from the secondary nuclei of the epithelium or from the nuclei of the threadlike processes of these cells, there seems to be a direct connection between these leucocytes and the epithelium. The formation of these leucocytes from the intestinal epithelium has no unimportant meaning in the process of nutritive absorption, especially of fats. The epithelial cells can in this way easiest turn the absorbed material into the blood circulation. In the crypts of the vermiform appendix of the guinea pig a basement membrane is seen running down toward the bottom of the crypt, where it stops, and the intestinal epithelium comes in direct con-

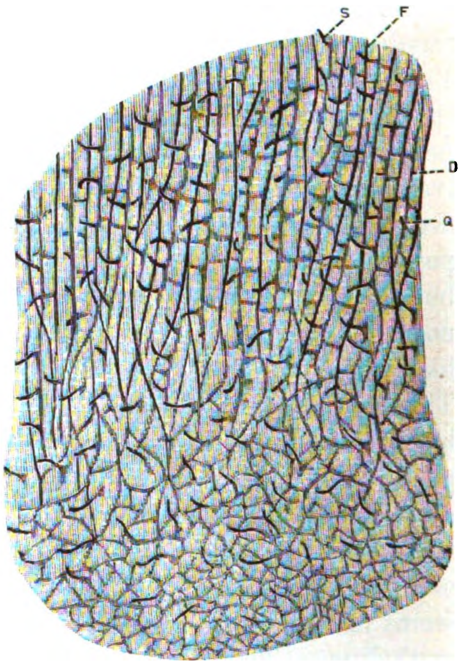
tact with the lymphoid tissue. (Fig. 14.) Here the epithelium is irregular in size and arrangement, and the difference between primary and secondary nuclei is indistinguishable. The intermediate zone appears as a wide-meshed net work of protoplasmic threads formed by the processes from the epithelial cells. In this are seen a variety of nuclei, the large primary, small nuclei having the same appearance, elongated nuclei like those in the basement membrane, and finally small secondary nuclei rich in chromatin, and so down to a point where smaller cells preponderate in the lymph glands themselves.

Anatomy of the Epidermis.—A. Blaschko's[10] investigations of the epidermis, have thrown new light on the structure of this layer, and are interesting as differing in many respects from the hitherto accepted descriptions.

The skin may be divided into smooth and hairy, the former including such portions as the volar surface of hands and feet, the nails, lips, nipples, parts



8. SURFACE VIEW OF THE RETE MALPIGHI OF SOLE OF FOOT OF NEWBORN CHILD.—(*Archiv f. Mikrosk. Anat.*)

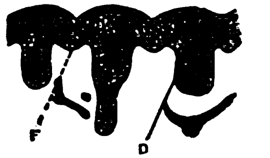


9. SURFACE VIEW OF THE RETE MALPIGHI OF FOOT OF ANOTHER CHILD; BORDER BETWEEN SOLE AND BACK.—(*Ibid.*)

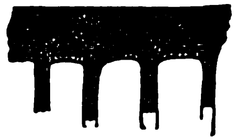
of external genitals, and the portion of the external auditory canal lying nearest the tympanum. In fig. 1 of the colored plate a transverse section through the sole of the foot of a young

monkey, is seen. Here the under epidermal surface shows twice as many prominences as are above; these cone-like bodies are, in

10. Surface View of Lower Side of Epidermis from End of Finger of Four Months' Embryo.—(*Archiv f. Mikrosk. Anat.*)

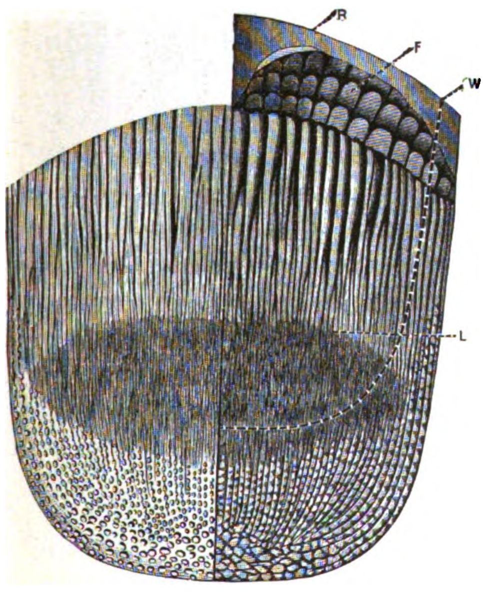


11. Transsection through Ribs and Furrows in the Hand of a Five Months' Embryo; Beginning of the Fold.—(*Ibid.*)



12. Section in Direction of Ribs. The Ridges have an Even Contour.—(*Ibid.*)

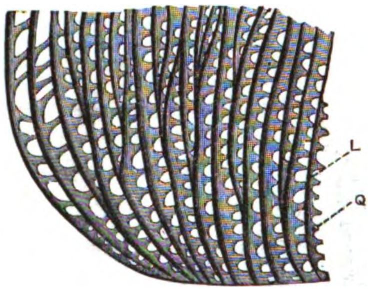
reality, transsections of longitudinally running ridges (leisten). The latter ridges are of two kinds, those which correspond to the ridges in which the sweat-glands open, the gland-ridges (d), and those found between every two gland-ridges dipping down under the furrows—the fold. Between the gland-ridges, the corium usually sends up a prolongation, but at times this is absent, and the folds are connected by a wall of epithelium (q). The meaning of this wall becomes evident in a section parallel with the epidermis (fig. 2). Here are seen the gland-ridges (d), with the openings of the glands (s), the fold (f), and between these the transverse ridges (q), these latter sometimes connected with each other by secondary ridges, which do not appear in the illustration. In the lower portion of this section, which is somewhat oblique to the epidermis, is seen the arrangement of the connective tissue



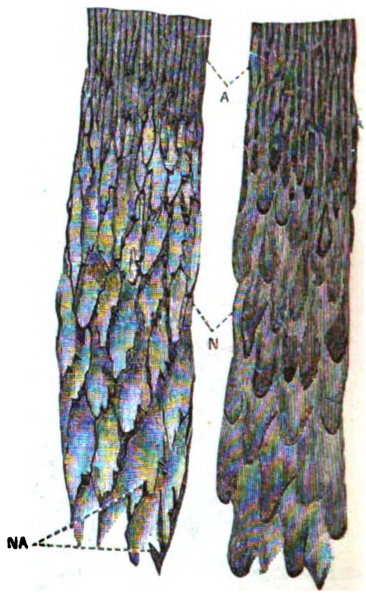
13. Left Nail-bed, Right Nail Inner Surface (Half Schematic).—R, free edge of nail; F, epidermis of finger end; W, line of nail wall; L, lunula.—(*Ibid.*)

fibres, which run parallel to the folds, and in the vicinity of the gland ridges, parallel, transverse or circular about the sweat canals. Below and above, the divided cutis-papillæ are seen as quadrangular spaces, between the longitudinal and transverse ridges.

In fig. 3, which is made up of several preparations, the three varieties of ridges are also seen. Here the lower contour of the gland-ridges and the fold appears even, except in those places where the trans-ridges give rise to a jagged or dentated look. The hand (fig. 4) and finger (fig. 5) skin show but a slight deviation in structure from that of the foot, the gland-ridges only appearing larger. The arrangement in the human subject before and at birth is essentially the same (fig. 6) as in the case of the monkey. Subsequent mechanical and other influences, however, produce a decided change; as the result of these, secondary (fig. 7 S Q) and tertiary ridges form, which do not run at right angles to the longitudinal ridges. In the human hand the fold is rather poorly developed, and the gland-ridges have an unsymmetrical appearance, being thin in one place and thickened in another, especially at the openings of the sweat-glands. This gives rise to wavy appearance of the contour.

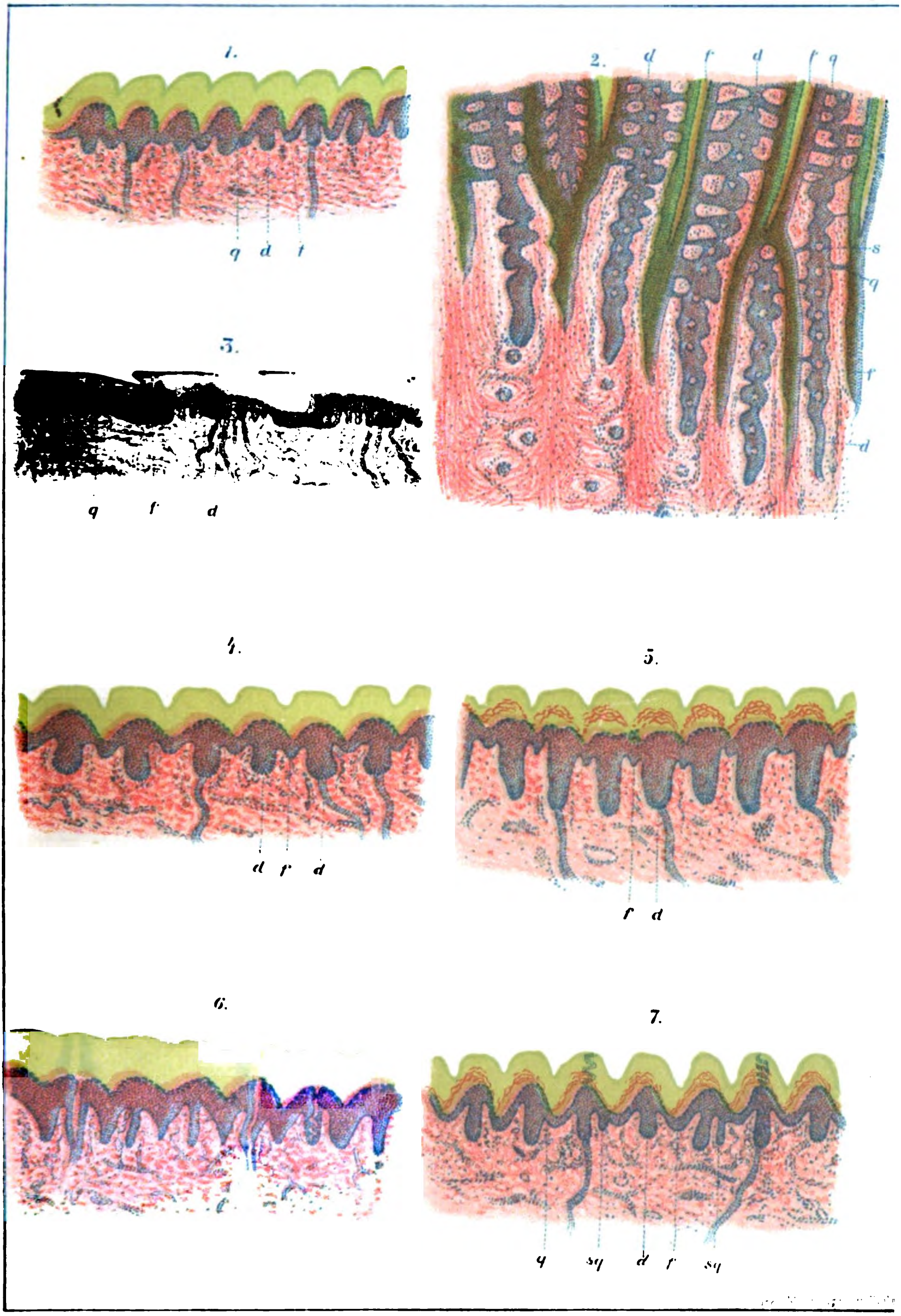


14. Inner Surface of Nail; Lateral, Proximal Zone.—L, longi; Q, trans-ridges.—(*Archiv f. Mikrosk. Anat.*)



15. Cutis Surface (Left) and Inner Surface of Epidermis (Right) of the Lips of a Two-years-old Child.—A, anterior, N, posterior zone; NA, papillæ of the corium, situated on comb-like ridges.—(*Ibid.*)

Figures 8 and 9 in the text show a surface view of the rete Malpighi from the sole of the foot of a newborn child. The reason that the primary trans-ridges are not so prominent as the

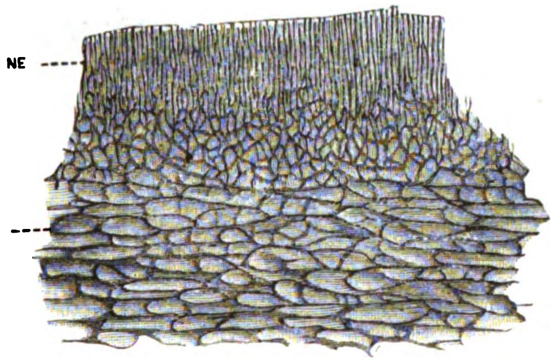


Anatomy of the Epidermis.

longitudinal ridges is explained by the fact that the papillæ rest upon cutis ridges, which run between and parallel longi-ridges. The secondary and tertiary trans-ridges correspond to the compound papillæ of the cutis. Figs. 10, 11 and 12, are from the finger and hand respectively.

Passing on to the nail, Blaschko differentiates two regions, which are plainly seen during the early years of life. In the anterior (distal) region, the rete shows a row of parallel longitudinal ridges, of which from two to five united at an acute angle at the anterior nail border to form a large ridge. In the posterior region the longitudinal ridges grow gradually smaller, divide now and then, terminate, and are replaced by spindle-shaped

16. Epidermis from Dorsum of Penis of Newborn. — s, sweat-glands.—(*Archiv f. Mikrosk. Anat.*)



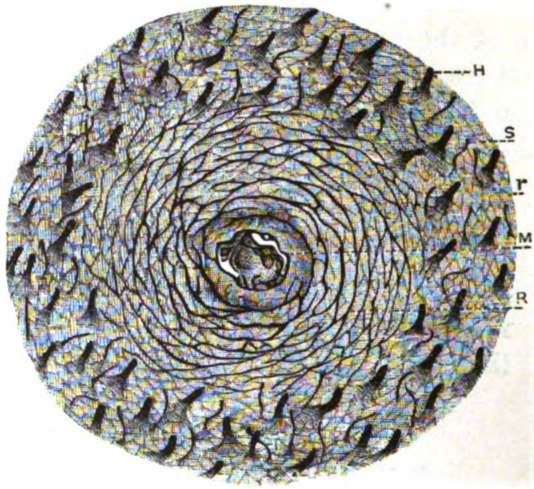
17. Epidermis from Corona Glandis.—(*Ibid.*)

bodies, which also run longitudinally, and are rarely connected by trans-ridges. The finger nail of the adult presents a characteristic appearance Here three zones can be made out, a distal zone with slightly developed ridges which divide posteriorly, thus increasing in number, but at the same time losing in size, until they reach the semi-lunal line where they break up into numerous finer ridges, forming a lenticular space. Beyond, the finer ridges reunite to form thicker bodies, and from these are given off trans-ridges. (Fig. 14.)

The difference in nails at various ages depends upon the greater development of the epithelial elements.

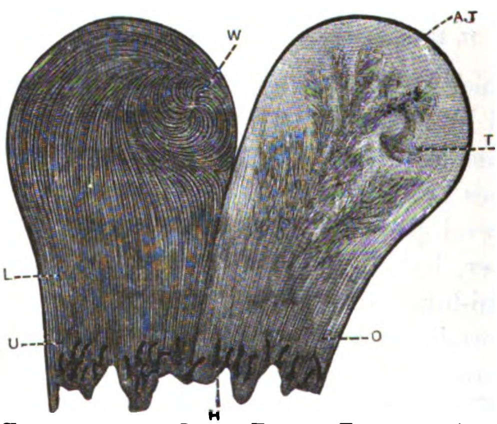
Luschka was the first to divide the lip into a *pars glabra* and a *p. villosa*, and Blaschko finds this arrangement quite satisfactory.

In fig. 15 a surface view of the lower lip is shown. In the anterior portion of this is an extensive net-work of connective tissue



18. INNER EPIDERMAL SURFACE OF THE MAMMA OF A NEWBORN CHILD.—M, opening of milk-glands; H, hair roots; r, network of prominent ridges; R, fine net-work between the hair roots.—(*Archiv f. Mikrosk. Anat.*)

and epithelial ridges, which is sharply defined from the eminences of the posterior (lower) part. These thickenings sink down into



19. EPIDERMIS FROM INNER END OF EXTERNAL AUDITORY PASSAGE (CHILD).—O, epidermis of upper and lower walls of passes; T, tympanum; AT, annulus tympanicus; H, hair root; W, ridge whorl.—(*Ibid.*)

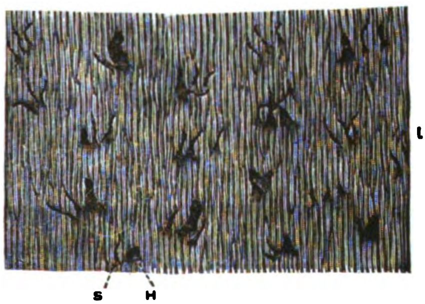
19a. POINT OF PASSAGE FROM UPPER TO LOWER WALL OF THE CANAL.—(*Ibid.*)

the rhomboidal meshes of the connective tissue layer. On the prominent margins of these meshes, numerous thread-like papillæ

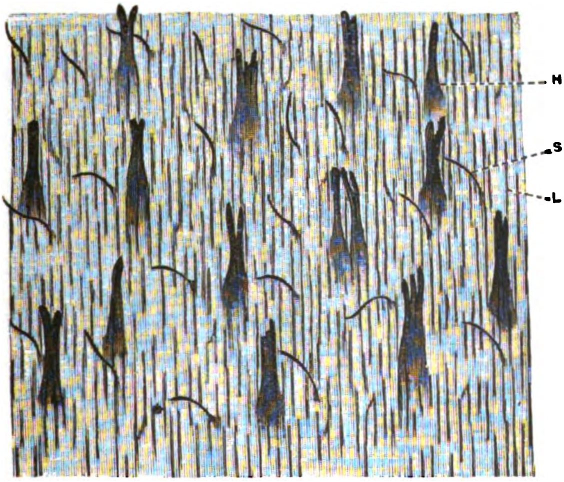
are seen; these increase in number and height toward the posterior portion. Occasionally such papillæ will be found anteriorly.

20. Skin from Forehead of Newborn Child.—H, stumps of hair roots.—(*Archiv f. Mikrosk. Anat.*)

21. Skin of Face, same.—S, sweat-glands.—(*Ibid.*)



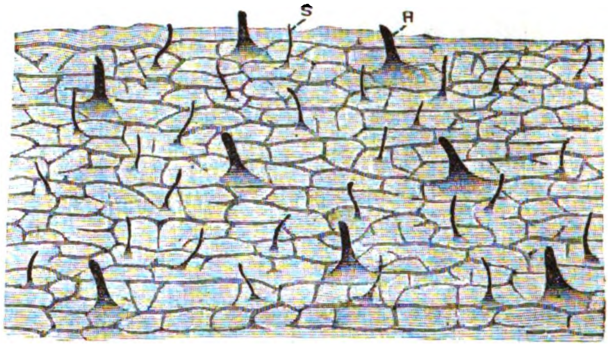
22. Skin over Sterno-cleido Mastoid Muscle.—(*Ibid.*)



23. Skin of Mons Veneris.—(*Ibid.*)

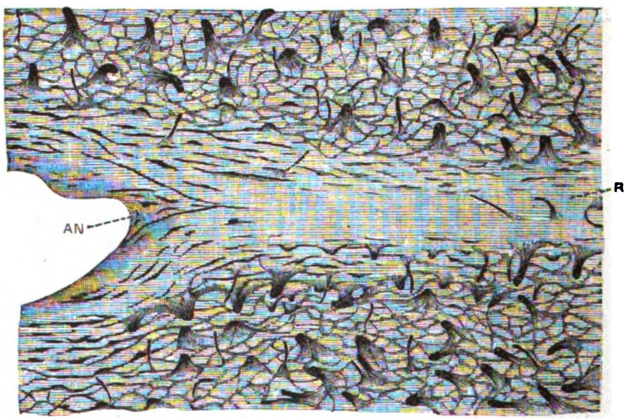
On the under surface of the epidermis of the nipple, Blaschko finds that the hair roots (fig. 18 H) stop short of the openings of

the milk ducts, while large and small epithelial ridges from this point run down to and around the openings. By crossing each other at right angles, meshes to receive the cutis papillæ are formed. (Fig. 18.) On the penis the epithelial ridges form a net-work of elongated meshes, into which the corresponding cutis ridges are



24. Skin of Abdomen.—(*Archiv f. Mikrosk. Anat.*)

inserted. (Fig. 16.) In fig. 17 (corona glandis) the ridges are closely crowded together until they reach the corona, where they spread out into a broad net-work of circular and radiating fibres. About the meatus, the ridges become more circular in direction,



25. Skin from Buttocks.—R, raphe perinei. AN, anal opening.—(*Ibid.*)

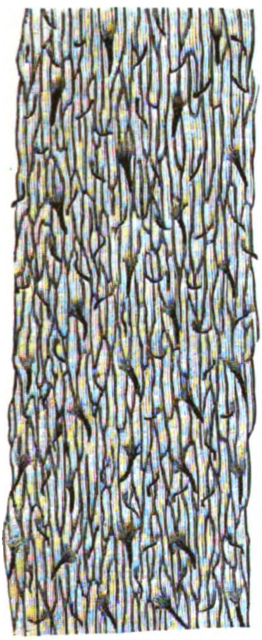
and the connecting ridges are shorter. Apparently all of the radiating ridges do not converge toward the urethral orifice, but run somewhat spirally around it.

In the folds between the labia, and on the external surfaces of the labia minora, there are no regularly arranged epithelial

ridges. In the inner surfaces of the small labia, however, there are large ridges, which spread out fan-like toward the introitus. These are connected by short trans-ridges.

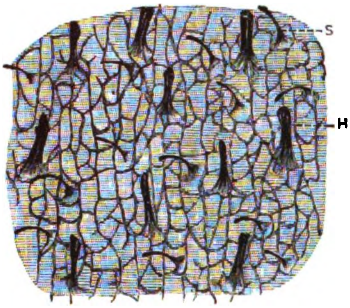
26. SKIN OF THIGH IN VICINITY OF KNEE-JOINT.—(*Archiv f. Mikrosk. Anat.*)

Kauffman has described the existence of cutis ridges in the skin of the external auditory canal near the tympanum. In this Blaschko agrees, but differs with Kauffman as to the direction taken by these ridges. Fig. 19 represents the actual arrangement of these. A few mm. in front of the drum the hairs stop, and ridges formed of rete Malpighi extend somewhat spirally to the lower border of the tympanum, here they end in a whorl. The arrangement of the ridges and the fact that they begin where the hair leaves off, leads to the conclusion that they are the anatomical equivalent of the hairs. Fig. 19*a* shows the point of crossing between the upper and lower auditory walls. Of the hairy epidermis there are four varieties: where there are no ridges and no cutis papillæ, only regularly arranged hairs,—this is found chiefly in the skin of the forehead (fig. 20) and the perineal raphé (fig. 25); where there are flattish ridges which occasionally fork, both arms running parallel, on the lower surface of the epidermis, best seen in skin of neck (fig. 22) or mons veneris (fig. 23); where the ridges form a half closed network, the trans-ridges often failing to reach these running longitudinally (fig. 24), seen to good advantage in the skin of the back

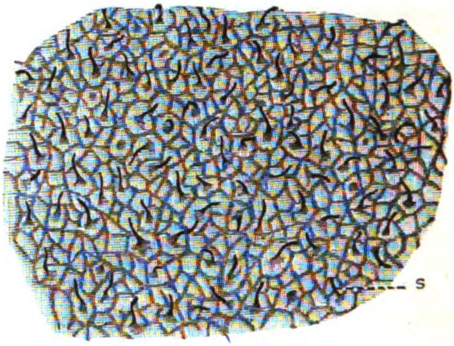


27. EPIDERMIS OF SKIN FROM BACK.—(*Ibid.*)

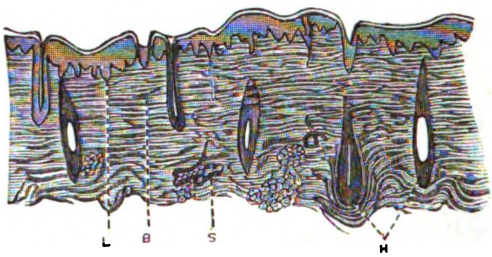
(fig. 27); where the epithelial ridges form a completely closed network, seen in skin of the head (figs. 30, 31), of the back (fig. 27),



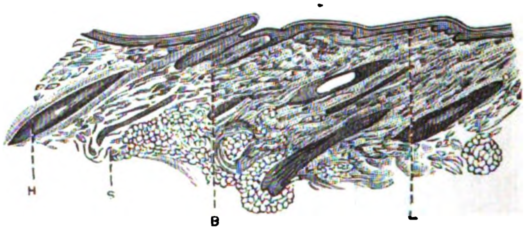
28. EPIDERMIS OF SKIN FROM HAND. —(*Archiv f. Mikrosk. Anat.*)



29. EPIDERMIS FROM EXTERNAL BORDER OF FOOT OVER CALCANEUS.—(*Ibid.*)



30. SECTION THROUGH SCALP OF A TWO-YEAR-OLD CHILD, PERPENDICULAR TO THE HAIR.—H, Hair follicles; L, Longi-ridge cut through; B, long section through connective-tissue fibres.—(*Ibid.*)



31. SECTION IN DIRECTION OF HAIR.—B, transsection of connective-tissue fibres.—(*Ibid.*)

of the buttocks. (Fig. 25.) The various arrangements may be seen in figures 26, skin from thigh near knee-joint, 28, epidermis from back of hand, 29, epidermis from external border of foot.

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[Undated references apply to journals published in 1887, and original articles can be found by consulting the indexes of the respective publications.]

EMBRYOLOGY ANOMALIES AND MONSTROSITIES.

By W. XAVIER SUDDUTH, M.D., F.R.M.S.,

PHILADELPHIA.

EMBRYOLOGY.

The past year has been one in which no inconsiderable advance has been made in the study of embryology. The work recorded has been done largely upon the lower animals, in whose analogous genesis may be reflected the problem of the beginning of life in man. The rapid strides made in our comprehension of the subjects of heredity give promise of great good to mankind at large, as well as of answering some of the deeper problems of etiology. Several valuable papers have been presented during the year on the conditions influencing the production of sex. The search for polar globules in the mammalian ova has been renewed with fruitful results. The subject of spermatogenesis has received full and intelligent consideration at the hands of Benda,[1] who bases his conclusions upon a long line of researches made upon the ox, rabbit, guinea-pig, boar, rat, mouse, dog, and cat. He finds that,—"(1) the seminal canals of the mammalia include two functionally different elements: the mother-cells, with their derivatives, and the basal-cells. (2) The process of spermatogenesis is accomplished in four stages: (*a*) multiplication of mother-cells; (*b*) formation of sperm-cells from some of the mother-cells; (*c*) copulation between the basal-cells and the former; (*d*) modification of the thus united sperm-cells into spermatozoa. (3) All the four acts occur by successive displacement. (4) The multiplication of mother-cells occurs by indirect cell-divisions in the most external cellular layer of the seminal canal. (5) The formation of a row of sperm-cells is effected by a preparative alteration in the position of the mother-cells. The latter multiply by indirect division in the inner layers of the canal, and some of the results form reserve mother-cells. (6) After the perfecting of a generation of sperm-cells, the basal-cells in the outermost zone conjugate with them, each basal-

cell uniting with a number of sperm-cells. (7) Contemporaneously with or immediately after the occurrence of this conjugation the sperm-cells begin to be modified into spermatozoa. (8) The nucleus forms the various parts; the cellular body is dissolved. (9) The portion of the nucleus nearer the point of copulation forms the head, the reverse the tail. (10) During their entire modification, the sperm-cells remain in organic connection with the basal-cell, and form by active and passive modifications of the latter a bundle of spermatozoa. (11) They are expelled as they actively or passively lose their connection with the basal-cell, and are pressed out laterally by the proliferation of adjacent elements. (12) The various steps occur regularly in each part of the tubule, so that certain events in successive rows of seminiferous cells always coincide. Thus the close of a period of modification coincides with that of the multiplication of sperm-cells. The beginning of the former occurs at the same time as the preparative alterations of the mother-cells; these preparative changes always occupy the same time as two periods of modification; two rows of sperm-cells are always in process at the same time; the close of each process of modification is contemporaneous with the perfecting of a generation of sperm-cells, so that at the end of modification the material for the next period is already in progress. (13) In each portion of a seminal tubule it is therefore possible to have a periodic secretion of spermatozoa, and an unbroken succession. (14) The secretory periods in the different portions of the tubule do not coincide. (15) By a regular alteration of the secretory periods in the different parts of the tubules there is a possibility for continuous secretion throughout the mammalian testis."

These investigations, following those of Geddes and Thomson,[2] give as complete a review of the subject as has been presented. The idea has been advanced that the ovum serves as the medium for the development of the male product, and as such plays a passive part. The law of heredity, however, seems to confront this theory at the outset, the mother, in most instances, stamping her individuality on the offspring more frequently than does the father. Geddes,[3] in an able paper, holds that the production of sex depends more upon the comparative physical condition of the ova and spermatozoa than upon any special sexual difference in the

tissues themselves, common characteristics being due to protoplasmic continuity in both the mother ova and the fertilizing spermatozoa after contact.

Zacharias,[4] in a series of studies on ascaris megalocephala, presents the physiology of the maturation and fertilization of the ovum, and holds that not only the nucleolus, but also the other parts of the blastodermic vesicle are stainable. The nucleolus lies upon the periphery of the nucleus membrane. In the lower portion of the Fallopian tubes it divides into two halves, which again subdivide and form two equally proportionate, rounded parts. The blastodermic vesicle shrinks and breaks up into filaments, which go to form the first and second acromatic polar globules. In this manner are formed two distinct spindle-shaped points, which follow the elimination of the first and second polar globules. A double fertilization also follows the development of the second polar globule, in which the chromatin of the sperm combines with the remaining chromatic portion of the ovum, and which is divided into two symmetrical halves. The coalesence of these elements occurs in the vicinity of the polar globules, and thus two segmented nuclei are formed, having, however, only a single function, namely, the formation of the filaments of the initial point (mutter stern) for the segmentation of the first globule. Both these points have been heretofore known as pronuclei, and entirely erroneous conclusions have resulted in consequence. The nucleolus now contains all the chromatic substance of the ovum and represents all the filamentous net-work of an ordinary non-functional nucleus with its nucleoli. This the writer calls the mitoblast, and differentiates a feminine mitoblast and a masculine mitoblast. The latter he understands to represent the unstainable portion of the spermatozoa. Fertilization of the ovum, according to this author, takes place as follows: The two classes of mitoblasts, male and female, form a cavity in the yelk, being separated from it by a distinct membrane; as a result, two chromatic points are formed, consisting of equal proportions of male and female elements. The mitoblastic portions disintegrate and form minute granules, which generate in time into the filamentous chromatic substance. The two stars take a position more longitudinal to each other. Instead of a single polar globule, two are remarked, occupying, however, the same position as the single globule, in consequence of which they generally form the initial

point of the filamentous star of the first polar globule, when each develops for itself two chromatic loops which assume a V form. When, therefore, each mitoblast assumes a separate nuclear form and the coalescence of the male and female chromatic element ceases, either the process will be recommenced, or else each will form for itself a filamentous structure; in which case we have a true male and female pronucleus formed as a result of the further development.

O. Schultze[5] has been led by his studies on amphibian ova to the general conclusion that there is a complete admixture of the female nuclear substance with that of the cell before fertilization takes place, after which a portion of the chromatic material passes to the surface of the egg and, passing through a double miotic division, gives origin to the polar globules.

Minot[6] lays great stress upon the significance, as regards the production of sex, of the discovery of polar globules in the amphibian ova, by Schultze, and thinks that they will be discovered in birds and reptiles when careful search is made for them. His views are to a degree substantiated by Blockmann,[7] in his studies on the ova of the maple louse, and by Weismann, who observed the same peculiarity in the ova of the daphnidæ. Haddon,[8] however, considers them as superfluous bodies.

The influence of gravity and position upon the segmentation of the ovum has received considerable notice during the past year. Roux,[9] in concluding the fourth of a series of articles on the mechanics of development, devotes his attention to the disposition of the direction of the median plane of the frog embryo, as determined by the direction of conjugation of male and female nucleus. He holds that in normal ova the axis occupies only one main direction. The fertilized side of the ovum becomes the ventro-caudal side of the embryo, the other the dorso-cephalic. The direction of the conjugation determines the direction of the first segmentation. When, however, the egg is fixed with the axis in a more or less oblique direction, an approximately transverse segmentation occurs, by reason of the obliquity of the axis,—segmentation in the normally situated ovum being either longitudinal or squarely transverse. The position of the germinal vesicle is also affected by the direction of the axis.

Fleischmann's[10] investigations upon the development of the

carnivora have been performed with great care. He has not been able to obtain the ova of the cat or dog in process of segmentation in the oviducts, but has made some observations regarding the attachment of the ovum of the dog, in which, as early as the twelfth day, small projections formed by an elevation of the ectoderm are to be observed on the side of the ovum, opposite to the blastosphere, which serve to attach the ovum to its nidus. Into these grows the outer vascular layer of the allantoic sac. The anterior portion of the amniotic fold in the cat, dog, fox, and mole consists of the epi- and hypoblastic layers only. Regarding the formation of the placenta, he confirms the statements of Bischoff, that the villi of the chorion grow into and destroy the uterine glands.

B. S. Schultze[11] presents an interesting article on the anomalous villous insertion of the umbilical cord, renewing the discussion begun some twenty years since, as to whether the fœtus atrophied or not when the allantoic vessels failed, primarily, to reach a particular point upon the membrana seratina. The question is of considerable interest, and Schultze's views particularly so. He held, at that time, from post-partum appearances of mature fœtuses, that such was not the case; that by far the greater majority of embryos would be well nourished and mature, in cases in which the allantois did not reach the chorion in the vicinity of the membrana seratina; that a perfectly normal placental insertion of the umbilical cord might take place, even when the vessels of the allantois attached themselves to the chorion a considerable distance from its attachment to the membrana seratina.

Schatz[12] also devotes a short article to the consideration of this subject, in which he takes exception to Schultze's views regarding the importance of post-partum appearances, and sets forth the idea that it is necessary that the allantoic vessels insert themselves in the chorion at a definite point in the first instance. He depends upon Pflüger's examinations and experimentations regarding the influence of gravitation upon the division of cells and the development of the embryo, and mentions the well-known effect of polarization upon the ova of lower animals in relation to warmth, light and oxygen supply, regarding the attachment of the allantois to the chorion in the same manner.

Schultze replies that in cases of twins, this rule is broken, and

that up to the end of the fourth week the embryo takes so little of the space of the chorion that both have plenty of space. The allantoic vessels of both embryos develop in this space toward the point where the chorion has attached itself to the wall of the uterus; the umbilical cord, if not hindered by adhesions, attaches itself to the chorion. When, however, the amnion of a twin can not locate itself upon the chorionic villi, because of the previous occupancy by the more distended amnion of the other embryo, the allantoic vessels of the first-mentioned embryo will attach themselves to the amnion of the more fortunate embryo. Such an insertion of the umbilical cord will necessarily be villous in character. The above explanation accounts for the more frequent occurrence of a villous insertion of the umbilical cord in embryos developed from twin ova over those from a single ovum. Placenta succenturiata represent a second form of anomalous attachment of the villi, where some few of the ramifications of the allantoic vessels, that should normally atrophy, persist and, growing through the tunica reflexa, attach themselves to the wall of the uterus. A third form of villous insertion is found in the above referred to twin ova when the allantoic vessels of either of the twins have reached the membrana seratina and attached themselves. The amnion of the other cannot reach the seratina because the amnion of the first occupies the space. The formation of the amniotic sheath of the umbilical cord of the first-mentioned embryo cannot, therefore, occur, and its umbilical cord must of necessity attach itself to the chorion at a point between the mutual chorion and the amnion of the other twin.

The most important paper on the human placenta that has appeared since Langhaus' memoir in 1877, is, in the estimation of Minot, the very brief article of Waldeyer,[13] which is replete with valuable information. By most scrupulously careful injections, he ascertained that the intervillous spaces are actually channels of the maternal circulation. The veins and arteries, as they enter the decidua seratina, completely lose all their coats except the endothelial lining. They pass up with this modification of structure through the decidua, giving off very few branches, and finally open directly upon the decidual surface into the intervillous spaces. Waldeyer leaves us in doubt as to whether there is any maternal tissue (that is, endothelium) covering the fœtal epithelium of the

villi, but is inclined to think such a layer is present. Minot, however, failed to find any traces of it in his preparations.

Phisalix[14] publishes the results of some studies on a human fœtus 32 days old. His observations regarding the disposition of the cardiac valves, the ventricular partition and the formation of Botal's foramen, differ from the generally admitted theory of His. Phisalix holds that the partition of the auricles is formed by single bodies, and not by the coalescence of indefinite, independent, and opposed valves. The valve of the foramen ovale may be connected with the occlusion of Botal's foramen, but it certainly has nothing to do with its formation.

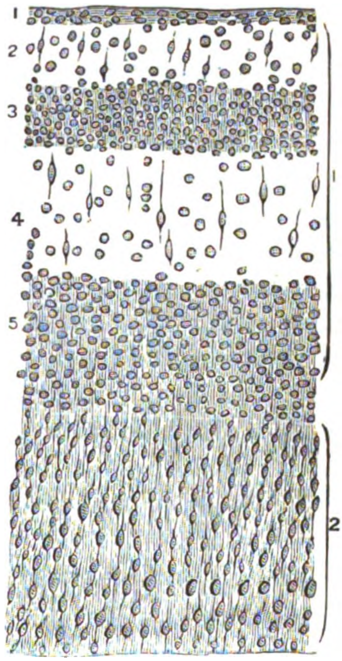

FIG. 1.—SECTION THROUGH THE CEREBRAL VESICLE OF A HUMAN EMBRYO, 3 C. M. IN LENGTH, FROM HEAD TO NATES.—1, gray substance; 2, white substance. 1, 2, 3, 4, 5, the five layers of the gray substance.

Hyaline Cartilage.—M. Renaut[16] gives some interesting points in regard to the old question as to the vascularity of hyaline cartilage, and, as a result of some new methods of experimentation, arrives at the following conclusions: that fœtal hyaline cartilage contains neither fibres proper, nor canals for transporting fluids; but that in this primitive hyaline matter there is a transparent formation which receives or gives off fluids with equal rapidity, and may be considered as the active agent in the rapid distribution of nutritive fluids in this compact tissue.

Gray Substance of Brain.—Gerlach,[17] of Erlangen, gives the result of his studies on the five layers of the gray substance of the cerebral vesicle in a human embryo 3 cm. from head to nates, and adduces the following conclusions: (1) In younger embryos the differentiation in the stratification of the gray substance is more marked than in older embryos. (2) Distinction of color decreases with advancing development, even after birth: in an adult it is almost impossible to show the five layers of the gray substance. (3) The first rudiment of the cerebral vesicle is morphologically

analogous with the gray substance of the convolutions of the cerebrum. (4) The white substance of the primary rudiment is minimum in thickness, but increases in proportion to the gray in thickness with the development of the embryo. (See Fig. 1.)

Involution of Fœtal Ducts.—Théremin[18] gives his observations on the condition of the fœtal ducts in over 500 autopsies on infants. He has noted separately the condition of the foramen ovale, the duct of Botal, the umbilical vein and the venous duct of Arantius. The results of his observations do not agree with what has been generally published on the subject. The umbilical vein was never found permeable at its junction with the portal vein in infants over four months old. The calibre of the portal vein in infants of this age varies considerably; and it must be supposed, *à priori*, that the cause of this difference depends upon the physical development of the child itself. In infants of from one to two weeks he obtained analogous results, but in children above that age the duration of disease and its effect on the ulterior development of the child must be taken into account. The venous duct of Arantius was constantly closed at its junction with the portal vein, and its internal circumference was less there than at the point where it joined the inferior vena cava. With the exception of two cases, the duct was found permeable previous to the eleventh day. In children over thirty days of age it was always completely closed, at least next the portal vein. After the twenty-first day it would admit the passage of a small probe, 17 times out of 68, or 25 per cent.

His observations on the foramen ovale were confined to the valve only, and he classifies the conditions as follow: (1) Foramen widely open; breadth of valve 1 to 2 millimetres. (2) Foramen half closed. (3) Foramen three-quarters closed. (4) Foramen closed, with exception of small segment, sufficient to allow the oblique passage of a probe. (5) Foramen completely closed. The foramen was never closed previous to the second week; between that time and the third month it was closed in 80 per cent. of the cases; and after the ninth month, always closed in normal cases. The size of the child seemed to have no effect on the development of the valve, this being alone influenced by the age. Botal's duct generally measured from 5 to 8 millimetres, although a more marked variance than this was observed. In six cases

classed as permeable, the duct permitted the passage of a small probe. In 34 out of 144 cases (23 per cent.), in children from six weeks to four months, the duct was still found open.

DEVELOPMENT OF THE GENITO-URINARY TRACT.

The facts here presented are drawn from Foster and Balfour,[19] Haddon,[20] and a series of lectures given by Professor Lockwood.[21] The illustrations are from the latter's article on development and transition of the testicles.

The embryonic excretory system is composed of three separate parts, each performing the office of excretion in as many separate stages of the evolution of the embryo. The first consists of the pronephros, or primitive kidneys; the second, mesonephros, or Wolffian bodies; the third, metanephros, or the kidneys proper. These, together with their excretory ducts and annexa, constitute the system under consideration. The development of the generative organs is so closely allied to the renal organs that it has been considered best not to devote space to their separate genesis. The initial step in the development of the pronephros is the formation of the segmental duct, on the anterior end of which the pronephros are formed, and with which they remain connected throughout their term of existence. The segmental duct begins as an open groove on the dorsal side of the embryo, and sinks into the subepithelial tissue, forming by constriction a duct, the development of which proceeds from the anterior extremity of the embryo, posteriorly in a manner similar to the neural groove, finally opening into the cloaca in the amphibia. Constriction at the anterior portion gives rise to the nephrostomata, from which prolongation extends to form the segmental tubes.

These latter become coiled upon themselves, and form, together with the segmental duct, the pronephros. Lockwood holds that nephrostomata are also to be seen in transverse sections of human embryos as early as the thirteenth day. (See Fig. 2.) In this specimen three well-marked protrusions were to been seen, the recesses between them in close relation to the Wolffian tubules. He thinks that these appearances indicate the existence of pronephros in the human embryo.

Waldeyer has been enabled to trace the so-called membrana prima of Hensen, which separates the infant or Malpighian layer

of the epiblast from the mesoblast, between the ingrowing bands of the embryonic tissue beneath. He also holds that the different appearances presented by the nuclei of the cells of the ridge, and the surrounding mesoblastic cells, indicate the epithelial origin of the former. Karyokinesis in all its stages is met with in the developing band, while the mesoblastic cells are generally quiescent. Although it is generally admitted that the pronephros are developed from the epiblast, considerable doubt exists as to the exact origin of the Wolffian body, or mesonephros. The majority of observers, however, seem agreed that in each a higher expression of evolution is represented in these separate excretory organs, in the order of their development, viz., pronephros, mesonephros, metanephros; the one forming from its predecessor, and all having the same primary origin. The metanephros, or permanent kidneys of the amniota are therefore only the highest expression of the excretory system in general. Lockwood takes strong ground against this view, and says that so far as he has been able to ascertain from the examination of numerous human embryos and rabbits, that the permanent kidneys, although so much like the Wolffian bodies in structure, are quite separate and distinct, even from their earliest origin.

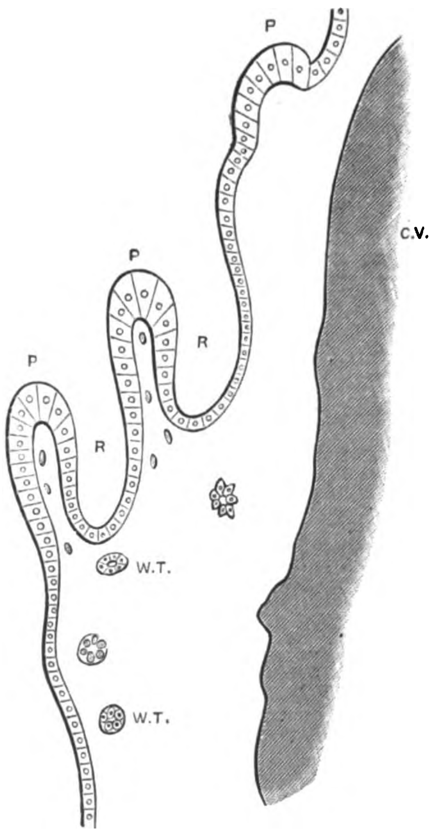

FIG. 8.—FRONT PART OF HUMAN WOLFFIAN BODY, TO SHOW THE APPEARANCES WHICH MAY BE SUPPOSED TO INDICATE THE EXISTENCE OF A FORE-KIDNEY (the embryo was at about the thirtieth day of intra-uterine life.)—C.V., cardinal vein; P., Protrusions into peritoneal cavity; R., recesses; W.T., Wolffian tubules.—(*British Med. Journal.*)

Sedgwick[22] has shown that in the chick the mesonephros has a double origin, (1) an outgrowth from the Wolffian or segmental

duct, and (2) from the intermediate cell mass. Lockwood holds that the most direct origin for these ducts would be from the segmental duct, but thinks that in the rabbit it can be shown that they arise from the intermediate cell mass only. Soon after the formation of the tubules in the rabbit, they become continuous with the inside of the duct, and eventually by a separation of the central cells, acquire a lumen opening into the lumen of the Wolffian duct. The number of Wolffian tubules developed are equivalent to about two or three for each somite in relation to the Wolffian body. Anteriorly the tubules are continuous with the peritoneal epithelium; but posteriorly they are separated. For a comparative study of the position of the excretory organs, see Fig. 3.

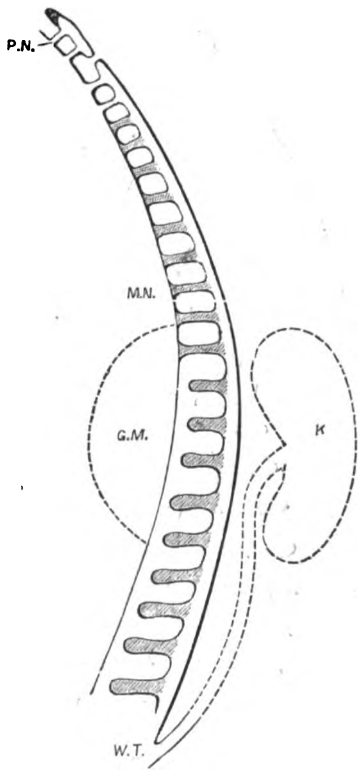

FIG. 4.—DIAGRAM CONSTRUCTED FROM A SERIES OF TRANSVERSE SECTIONS OF A RABBIT'S EMBRYO AT THE THIRTEENTH DAY OF INTRA-UTERINE LIFE. To show pronephos and mesonephros or Wolffian body. The future positions of the permanent kidney and genital mass are indicated. —P.N., Pronephos; W.T., Wolffian tubules; G.M., Genital mass; K., Kidney.—(*Brit. Med. Journal.*)

Lockwood's researches on a human embryo of 23 days, which is not larger than a common housefly, $\frac{7}{32}$ of an inch, shows that the body cavity is divided into two separate compartments: a superior, containing the heart, and an inferior, the liver, lungs, alimentary canal and Wolffian body. Owing to the absence of the diaphragm, there is no separate pleural cavity, and the lungs occupy the upper portion of the pleuroperitoneal cavity. (See Fig. 5.)

The Wolffian body, by reason of the size of its glomeruli, formed a very conspicuous object, occupying almost the entire posterior portion of the pleuroperitoneal cavity, and reaching as far forward as the heart and lungs. It was tapering anteriorly, but full and round posteriorly, and constituted fully one-sixth of the entire bulk of the embryo. While the mesonephros forms an important feature in embryonic

life, yet it does not persist as an excretory organ in the mature amniota.

Lockwood made studies from a human embryo, in which the fore and hind limbs had just begun to appear. The specimen measured one half inch in length, and represented about the 26th day of intra-uterine life. Sections made transversely through the middle of the embryo, showed cross sections of the stomach, duodenum, liver and Wolffian body. (See Fig. 6.)

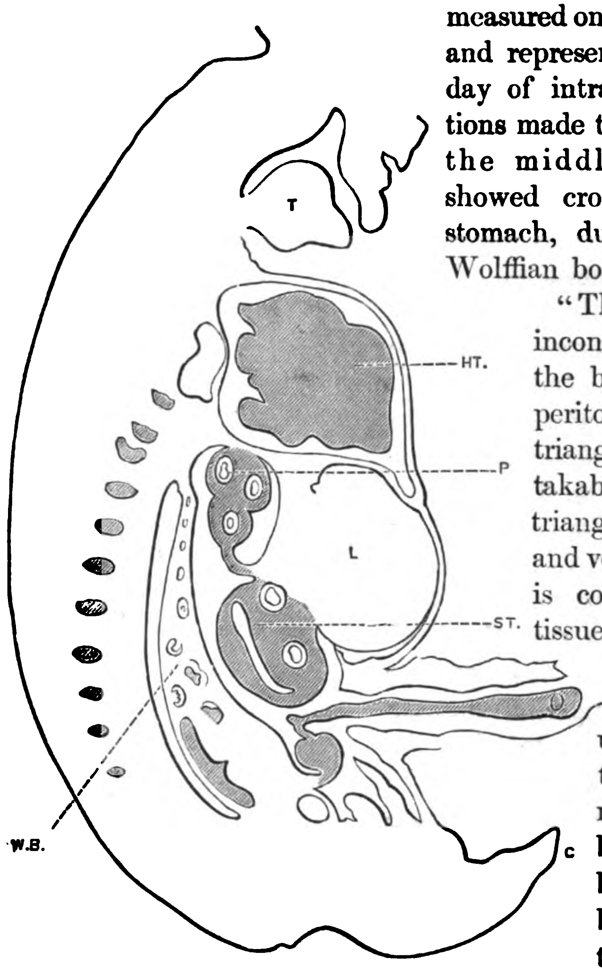

FIG. 5.—LONGITUDINAL SECTION, x 80. HUMAN EMBRYO, TWENTY-THREE DAYS (?). To show size and position of the Wolffian body (W. B.) T. Tongue and lower jaw; Ht. Heart; L. Liver; P. Lungs; St. Stomach (divided twice); C. Tail.—(*Brit. Med. Journal.*)

"The latter occupies no inconsiderable portion of the back of the pleuro-peritoneal cavity, and its triangular shape is unmistakable. The base of the triangle is toward the aorta and vertebral column, and is continuous with the tissues which surround the parts; the other sides are unattached and extend into the peritoneal cavity. The bulk of the Wolffian body consists of embryonic connective tissue, and its surface is covered with a layer of cells, which are thickest and most columnar in the most prominent part of the organ. Beneath this covering, and near the apex of the triangle, there is a ring of concentrically arranged cells, surrounding a small lumen; and this represents the Wolffian duct. On either side, coiled tubules—the Wolffian tubules—are apparent; and on

one side, the spectator's right, the tubule seems to open into the duct. Moreover, in all probability, the tubule is connected with a large glomerus, for on either side these structures are prominent objects. The large veins in the back part of the Wolffian body—the cardinal veins—are the channels by which the blood from the primitive kidneys is returned to the heart."

The Wolffian duct arises from the segmental duct, which divides longitudinally into two separate ducts. The dorsal one gives rise to the Wolffian, while the ventral one is known as the duct of Müller. The latter fails to develop in the male, although

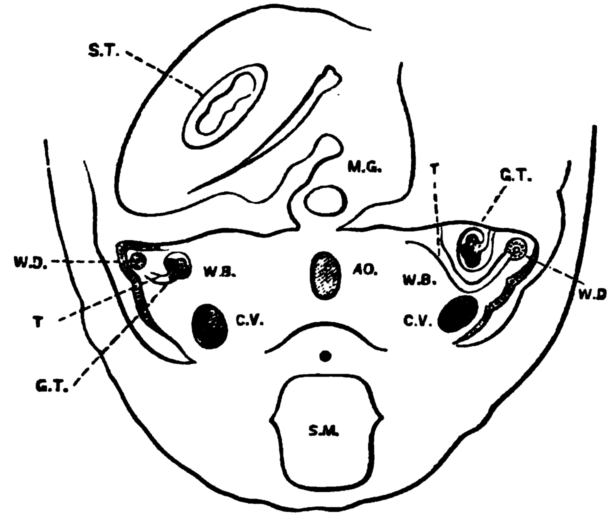

FIG. 6.—TRANSVERSE SECTION. HUMAN EMBRYO, TWENTY-FIVE DAYS x 30. TO SHOW WOLFFIAN BODIES IN TRANSVERSE SECTION. St. Stomach; M.G. Mesogastrium; W.B. Wolffian body; C.V. Cardinal vein; A.O. Aorta; S.M. Spinal medulla; G.T. glomerulus; T. Tubule; W.D. Wolffian duct.—(*Brit. Med. Journal.*)

present in the embryo. In some instances it persists as a solid cord, and is held by some authors to form the hydatids of Morgagni. Lockwood says the close resemblance of the human Wolffian body to the excretory organs of other vertebrates is very marked. The urogenital ridge in which the immature Wolffian body lies, contains, besides a quantity of mesoblastic tissue and the covering epithelium, ducts, tubules, glomeruli and blood-vessels.

Little or nothing has been written regarding the development and histology of the glomeruli. In the youngest human embryo studied by Lockwood they were to be seen in the very earliest stages of their formation. (See Fig. 5). The development being

concomitant with the budding of the limbs, and subsequent to the formation of the ducts and tubules, the latter become enlarged and markedly altered by internal cell multiplication, which results in the formation of a short tube, lined with columnar epithelium, that here and there has a tendency to send branches into the lumen of the tubules. The Wolffian tubules consists of (1) a section known as the peritoneal funnel, in which is located the peritoneal opening; (2) a dilated vesicle into which the latter opens; and (3) a coiled tube connecting this vesicle with (4) a more distended portion which opens into the Wolffian duct. The tubules present no peculiarity at their openings into the Wolffian duct either in the rabbit or human embryo. This statement is opposed to that of some other authors, who have attempted to show that nephrostomata exists at the anterior end of the Wolffian body.

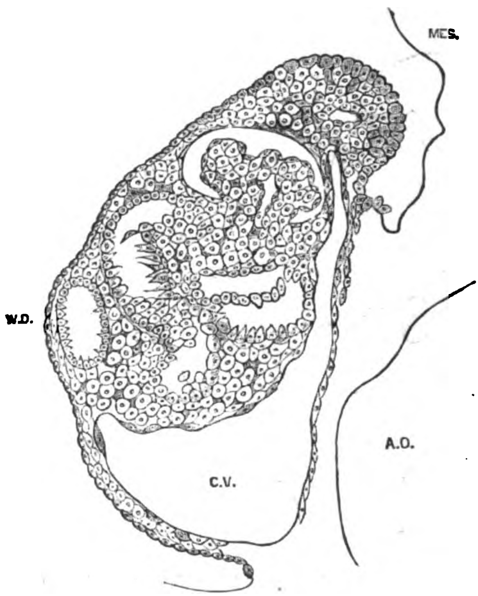

FIG. 7.—WOLFFIAN BODY AND SEXUAL EMINENCE OF RABBIT AT THIRTEEN DAYS. The section is at about the middle of the sexual eminence. W. D., Wolffian duct; C. V., Cardinal Vein; MES., Mesentery; AO., Aorta. To show that the genital eminence consists of primordial ova and branched anastomosing cells. —(*Brit. Med. Journal.*)

With the exception of the anterior tubules, which disappear early, the end of the Wolffian tubules farthest distant from the Wolffian duct becomes expanded, and a bunch of capillaries grows (in the manner stated) into the lumen of the dilated duct. So far as rabbits and human embryos are concerned, only internal glomeruli—that is, glomeruli grown directly into tubules—call for description; for the various specimens of rabbits' embryos do not warrant an agreement with Renson, who says that external glomeruli may be seen in that animal. In the human embryo certain vascular protrusions do exist; but it is not certain that they correspond to the external glomeruli seen in connection with the

fore kidney of the chick and various other animals. However, the mature internal glomerulus of the human Wolffian body is a conspicuous object, and remains so until the third month of intra-uterine life, or even later. The stroma of the Wolffian body is also of some interest, for it consists of a beautiful reticulum of nucleated branched anastomosing cells, which together form a matrix similar to that which is found in the developing kidney and testicle and in other parts of the embryo. The ventral surface of the Wolffian body, the site of the development of the generative organs, previous to the development of the ovary or testicle, becomes more or less complex. It is impossible to predicate at this stage of development, the ultimate sexual fate. This point or surface has been termed their sexual eminence. (See Fig. 7.)

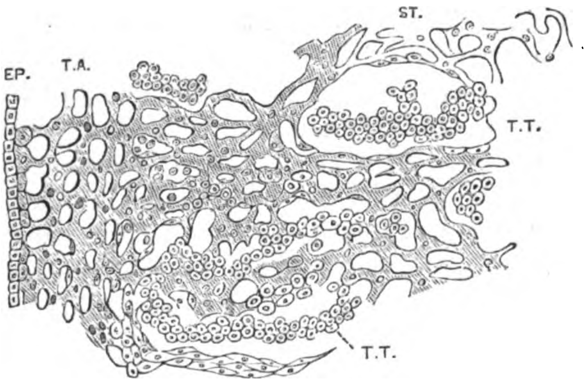

FIG. 8.—HUMAN TESTIS (TEN WEEKS).—EP., Epithelium; T.A., Tunical albuginea; ST., Stroma; T.T., Tubuli testis.—(*Brit. Med. Journal.*)

With the development of the genital eminence, the character of the Wolffian body changes. It loses its excretory power, and the metanephros are developed and assume their function as excretory organs. The genital mass in both sexes consists of a framework of anastomosing connective tissue cells, in the meshes of which lie embedded numerous round, nucleated, non-fibrillated cells. From the latter the tubules originate, while the tunica albuginea and fibrous tissue of the testicles are formed from the former (Fig. 8). The remaining portion of the Wolffian body gives rise to the embryonic remains in the neighborhood of the head of the epididymis and the digital fossa.

The phenomenon of the descent of the testicles is divided into two stages: (1) the apparent movements within the abdomen, due to growth of surrounding parts; (2) the actual migration down the inguinal canal into the scrotum, due to the traction of the muscular fibres of the gubernaculum. The migration of testicle into the

scrotum had lately been considered by Bland Sutton[32] to be of the nature of a perpetuated hernia. Lockwood, however, points out that the term hernia is used in two different senses. Sometimes it implies merely an anatomical condition, viz., the escape of organs from their containing cavities; at other times the word hernia is used to connote a pathological change. Taken in its pathological, and not in its anatomical, sense, it is clear that the word hernia ought not to be used in explaining the transition of the testicle, for the simple reason that the pathology of hernia is as yet quite undecided. The question still remains to be settled whether inguinal hernia is due to (*a*) a defect in the abdominal walls, (*b*) an elongation of the mesentery, or (*c*) to a general defect of the peritoneum.

The various specimens included under that heading belong to the infantile variety, and are similar to the case described by Hey. The formation of the sacs of infantile herniæ is attributable to the action of that part of the gubernaculum which is contained in the plica vascularis, because muscular fibres recognizable as a part of that prolongation are, in many specimens, found attached to the extremity of the sacs of infantile herniæ. (Fig. 9.) Without doubt all the sacculations found at the back of congenital hernial sacs were not attributable to this cause. Other structures, in addition to those mentioned, accompanied the testicle in its descent. It was not unusual in fœtuses to observe that the subperitoneal fat had also migrated with the testicle and cord from the abdomen. An overgrowth of this fat is believed to account for the appearance of lipomata of the spermatic cord.

At the sixth or seventh month, fibres are seen piercing the lower part of the abdominal wall, and extending into Scarpa's triangle; others are attached to the pubes and root of the penis; and others, rather later on, to the bottom of the scrotum. Moreover, at the eighth month, sections through suitably prepared fœtuses demonstrate that many of the lowest fibres of the gubernaculum pass into the perineum, and end over the tuberosities of the ischium, or by blending with the sphincter ani. These dispositions of the fibres of the gubernaculum are supposed to account for the occasional passage of the testicle into Scarpa's triangle or into the perineum. In the latter case it was usually found that the organ was attached by a band either to the tuberosity of the ischium or to the sphincter ani.

ANOMALIES.

From the foregoing observations on the development of the genito-urinary tract it will be seen that an arrest in normal development of the embryo will give rise to a pathological condition in the mature product. Lockwood met with one such malformation. (See Fig. 9.) Such instances, however, are of rare occurrence.

Non-descent of the Testicles.—Bland Sutton[23] describes four cases where non-descent of the testicles occurred as a result of peritonitis in intra-uterine life, and points out the probable connection between the descent of the testicles and the descent of the colon. The latter structure, he says, at one period of embryonic life, is situated in the left iliac region, and gradually passes upward and to the right side, occupying a position immediately under the liver; and from this situation it gradually descends to the right iliac region, its normal position. Should peritonitis intervene this remarkable journey is interrupted, and the colon may be arrested in any part of the course, the most frequent point being immediately under the liver. In four other cases examined, the testicles were adherent and unable to descend. The connection between the descent of the testes and colon is something more than casual. In several instances of congenital funicular hernia (right) he has found the vermiform appendix and cæcum in the pouch, and in two cases they were united to the testis and wall of the pouch by connective tissue bands.

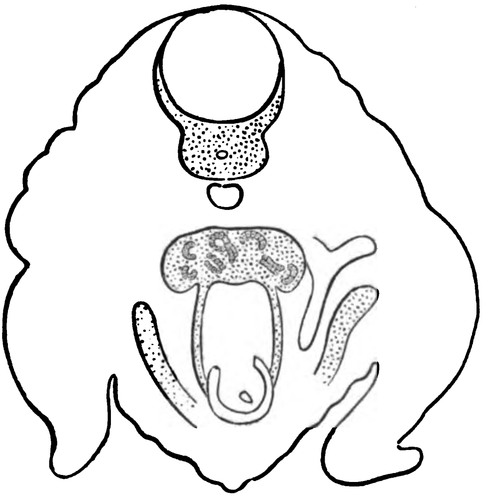

FIG. 9.—WOLFFIAN BODY AND DUCTS OF EITHER SIDE UNITED IN THE MEDIAN LINE. HUMAN FŒTUS 23D DAY.—(*Brit. Med. Journal.*)

Anomaly of the Cæcum.—The subject exhibiting such an anomaly was a man 50 years old, who came under the care of Hartmann.[24] The cæcum was situated immediately beneath the liver on the right side of the neck of the gall-bladder. A loop of

intestine was fixed in the right iliac fossa, in the place normally occupied by the ascending colon, and was united to the posterior wall of the abdomen by a short mesentery. It opened perpendicularly into the cæcum, which latter organ was horizontally situated, with its fundus directed to the right. The omentum was only attached to about two-thirds of the transverse portion of the colon.

Congenital Displacement of the Bowel.—Eustace Smith[25] reports a case of congenital displacement of the bowel in an infant of two months. During life it caused marked dyspnœa and great abdominal pain, the paroxysms only lasting for a few moments at a time. As a consequence of a congenital deficiency in the ligamentum arcuatum externum, about one inch in diameter, the whole of the large bowel had passed into the left side of the thorax. The lung had evidently never been inflated, but lay flattened against the spine. The cæcum was located in the abdominal cavity just below the diaphragm. The intestine was not inflamed, neither was the pleura. The displaced heart lay under the right lung. The spleen was also displaced downward from under the ribs.

Brigade-Surgeon Curran[26] also reports a case of congenital displacement of the stomach and bowel through an opening that existed in the left tendon of the diaphragm in a patient aged 19. The organ had pressed upon the left lung until it had lost its elasticity and weighed only six ounces. The heart was also displaced downward and to the right. No evidences of recent rupture or tear were visible. The spleen was found in the thoracic cavity and its normal position was occupied by the left kidney. Several coils of the large and small intestine were also found in the thorax.

Anomaly of the Colon and Peritoneum.—Allen J. Smith,[27] describes an anatomical anomaly of the colon and peritoneum. "The cæcum lay in the normal position. The colon ascended on the right side to the lower surface of the liver, where, doubling on itself anteriorly, it passed downward; and when again in the right iliac region passed transversely across the hypogastric zone to the left iliac region. Here it turned upward, passed up to the left hypochondriac zone along the anterior wall of the abdominal cavity, where it doubled on itself posteriorly, and passed down to the sigmoid flexure. The gastro-colic omentum, usually insignificant in measurement, extended here six or more

inches along the longitudinal axis of the body. The great omental apron was represented by a mere rudiment seen along the lower surface of the transverse colon.

"Lifting up the transverse colon, another singular condition presented itself, explaining the unusual course of the colon. The transverse meso-colon was present, but entirely unattached to the posterior wall of the cavity, and limited posteriorly by a curvilinear free margin. At its widest point this meso-colon measured three inches and formed the posterior wall of a large pocket, the anterior wall of which was represented by the broad gastro-colic omentum; and in this pocket lay all the small intestine except a few inches of the lower portion of the ileum."

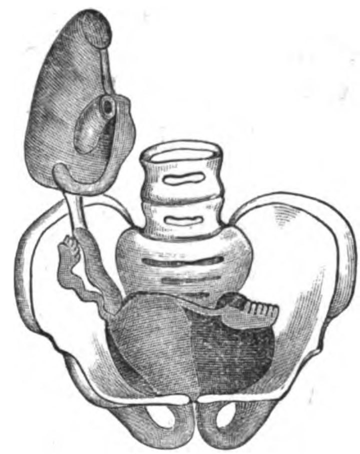

FIG. 10.—ANOMALY OF KIDNEY.—(*London Medical Record.*)

Anomalies of the Kidneys.—Bland Sutton[28] reports two cases of misplacement of the kidneys, one in a female fœtus (see Fig. 10), where, as a result of extensive peritonitis, the coils of the small intestine were glued together, and the colon lay under the liver, and was firmly adherent to the ventral aspect of the kidney. The right ovary and Fallopian tube were firmly fixed by stout adhesions just beneath the crest of the ileum. The uterus, in consequence of the fixed position of the ovary, was drawn out of position, and lay in contact with the right side of the true pelvis.

The other case cited was in a man 30 years of age, in which the right kidney was normal in form, size, position and vascular supply; while the left, very much misshapen, was suspended from the common iliac vessels by four arteries and lay over the left sacro-iliac synchondrosis, being covered by the first part of the rectum. Three arteries entered at the hilus: one was derived from the left and two from the right common iliac arteries. (Fig. 11.)

Gruber[29] records an extremely interesting case of an anomalous kidney. This organ, taken from the body of a middle-aged man, lay upon the right side of the vertebral column in the lumbar region and the upper portion of the right iliac fossa.

It was composed of two segments: the upper, corresponding to the right kidney, was vertically situated, while the lower, somewhat longer, occupied a transverse position and represented the more or less fully formed left kidney. The two parts were united. Both ureters ran upon the right side of the vertebral column, but opened normally upon either side of the bladder, which was diverted to the right side. The malformed kidney was supplied with five arteries and three veins; three of the arteries sprang from the right side and three from the left. The right superior artery arose from the right side of the abdominal aorta, and divided into two branches, as did also the median artery somewhat lower down. The inferior artery came from the right common iliac; the left superior artery was given off from the left side of the abdominal aorta and the left inferior from the left common iliac. One of the veins came from the upper hilus, two from the lower. The inferior one wound around the aorta and, passing behind it, entered the inferior vena cava on its left wall. This vein received the left suprarenal vein.

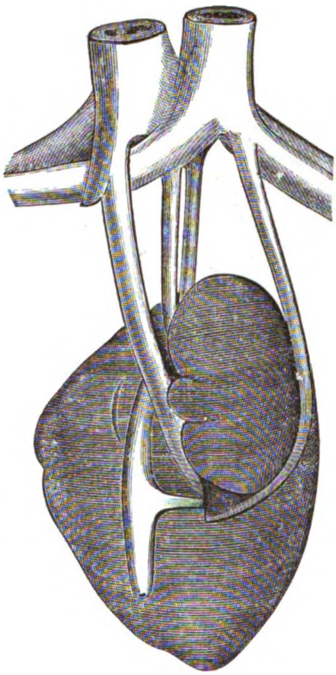

FIG. 11.—A KIDNEY WHICH OCCUPIED THE LEFT SACRO-ILIAC SYCHONDROSIS.—(*London Med. Record.*)

Liebmann[30] reports a case of a ten year old girl, who died of uræmia from nephritis parenchymatosa, in whom the only kidney, elliptic in form, possessed two suprarenal capsules, and lay in the pelvis upon the sacrum. It measured 11 cm. in length and 6 in breadth. The right ureter was developed and opened into the bladder; the left was rudimentary. The capacity of the bladder was normal, spindle-shaped, and possessed a short urethra with a broad opening into the vestibule.

Menzies[31] reports two cases of anomalous kidneys. In the first, the right kidney was absent, no trace of even a rudimentary organ being present. The renal artery was also absent. In the second instance, the left kidney was absent, with no renal or supra-

renal artery. The right kidney was supplied with three arteries, the two anomalous ones rising from just above the bifurcation of the aorta and right common iliac respectively. The writer had not seen any other similar cases in 1790 post-mortems made in the county asylum previous to these.

Mackey[32] also reports a case of solitary kidney, removed from a boy of two years and nine months. This kidney, the right, was twice its normal weight, and much thicker than usual, occupying a position somewhat higher than normal and nearer the median

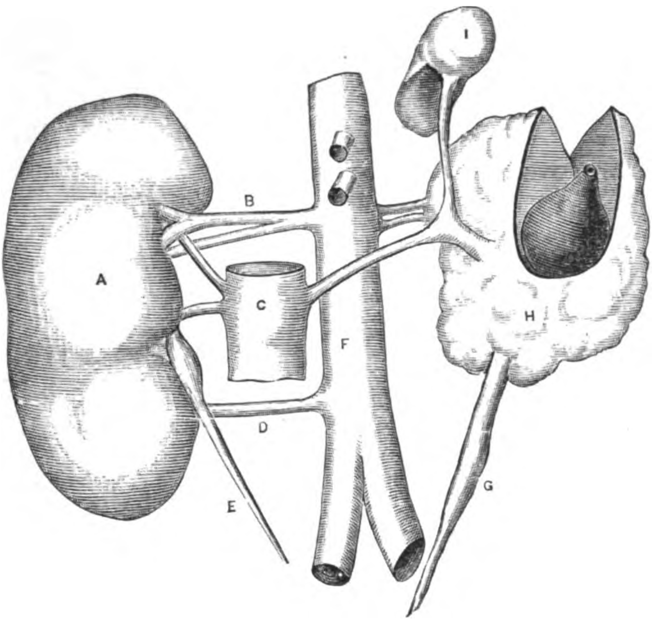

FIG. 12.—A, right kidney; B, right renal artery; D, supplementary renal artery; E, ureter, right; G, ureter, left, much dilated; I, suprarenal capsule anomalously located; H, left kidney, in which was found a calculus; C, vena cava.—(*Le Progrès Méd.*)

line. The suprarenal capsule was large, the ureter was not bifid and entered the bladder less obliquely than usual. There was no trace of a second orifice, every vestige of the left kidney and suprarenal capsule being absent. With the exception of the absence of the left ureter, the bladder was normal.

Pozzi and Grattery,[33] in a case of pseudo-hermaphroditismus, found a remarkable anomaly of the kidneys. The right was very much larger than normal, and its anomalous arterial supply spoke for the congenital origin of the malformation. (See Fig. 12.)

Couder[14] reported a case of single kidney (right) in a man of 72. It was very much hypertrophied, but occupied its normal place. The left kidney was represented by a mass of fatty tissue. A single ureter only connected the right kidney with the bladder.

Abnormal Urachus.—Of three cases recorded by Frëer[35] the first was in a 3 year old boy, in whom urine exuded from the umbilicus in sufficient quantity to excoriate the neighboring skin. No treatment proved of any avail. In the second case, a woman of 40, pus was discharged through the navel from time to time, in considerable quantities. A sound could be introduced into a large cavity in the abdomen. Fluid could be injected through into the bladder. The third case, that of a young man of 24, who was repeatedly tapped and a reddish fluid removed in amounts varying from one to three pints. The case ended fatally. Post-mortem examination revealed a large sac, which was undoubtedly the dilated urachus.

ANOMALIES OF THE PRODUCTS OF THE MULLERIAN DUCT.

Uterus Didelphys.—An uterus didelphys cum vagina duplice, in an otherwise normally developed person, is of rare occurrence. The cases of LeFort, Ollivier, Benicke, Freudenberg, Dirner and Kubassow are the only ones hitherto reported. To these may now be added a case seen by Strauch,[36] the discovery of the bifid condition of the uterus having been made upon the childbed. The patient, aged 22, had menstruated regularly since she was 15 years of age, was otherwise normally developed, with large pelvis, and outer genital organs normal; and the lateral portions of the vagina were found separated into a larger right and a smaller left. Recto-vaginal examination by the right vagina showed a uterus somewhat enlarged, on the left side of which another apparently normal uterus was to be felt. The right uterus measured 9 centimetres, and the left 7 in length. Engle[37] also reports an interesting case of conception and successful labor in a case of double uterus, vagina and bladder. Menstruation in this instance was retarded until the 25th year.

Simpson[38] reported to the Toronto Medical Society a case of bicornate uterus, where the malformation was not discovered until after the fifth pregnancy.

Rey[39] reports a case of uterus bicornis found in a pregnant

woman. The uterus was greater in breadth than in length, and a septum was easily discerned within the median line, dividing it anteriorly posteriorly into two halves.

Absence of Uterus and Vagina.—Ferris[40] gives an account of a case upon which he operated for artificial vagina, on a woman æt. 20 who had never menstruated. An incision between the labia and penetration with the finger of the cellular tissue to the depth of four inches, revealed the transverse band spoken of by authors, running across the pelvis, in a direction from one ovary to the other. Not a trace, however, of even a rudimentary uterus could be discovered.

Absence of Uterus, with more or less Normal Vagina.—Grechen,[41] relates a case of a young woman who came to him complaining that while she had not menstruated up to the present time, 27 years, yet regularly every month since she was seventeen years old she had suffered with severe pain in the abdomen and sacrum, lasting from two to three days. The vagina was from 7 to 9 centimetres long, and ended in a blind cul-de-sac. Bimanual examination by both vagina and rectum, also per rectum with sound in the bladder, revealed a complete absence of the uterus. Both ovaries were discoverable, and appeared normally developed.

The following case, reported by Max Kahn,[42] is also of interest as adding to the small list of abnormalities in this line. The patient, æt. 21, complained of amenorrhœa. The vagina, 6 to 8 centimetres long, ended in a blind cul-de-sac at the posterior extremity, was very movable and easily inverted. The most careful bimanual examination failed to reveal any trace of uterus. It was possible to make out cross-bands, but they could not be followed any distance. Examination per rectum substantiated the diagnosis.

Tschuevsky,[43] of Khiev, details a case in which the uterus could be felt as a small lump at the end of a short vagina, the latter being 4 cm. in length. Bimanual examination revealed the absence of the left ovary, while the right presented in rudimentary form. The pelvis was considerably narrower than usual. The external genitals, however, were normal, but the left mamma was one and a half times larger than the right. The woman presented other marked congenital deformities, scoliosis, brachiodactylie, and a diminution in the size of the left scapula.

Abnormalities of the Vagina.—Frazer[44] reported a case of a

double vagina in which the septum, for the lower inch and a half, normally existing between the two Müllerian ducts, remained intact, thus forming a pseudo-vagina duplice. The vaginal orifices for both vaginæ were visible and each surrounded by strong sphincter muscle; the partition between the two was similar in appearance to the labia and studded with the usual hairs. The natural orifice had a well-marked urethra and clitoris, and normally formed labiæ. The labiæ minoræ of the supplemental opening were distinct, and possessed of a fourchette, but no clitoris.

Guzzoni[45] cites a case of vagina duplice et uterus simplex. The vagina was separated by a well-marked septum, extending as far as the os of the rather long, conical-shaped uterus. The os deviated to the left with a single orifice. Both vaginæ were furnished with hymen.

Davillier[46] reports a case of bifid vagina in a patient aged 18, who at the time he was consulted, was suffering from peritonitis. Upon making a vaginal examination he found a narrow, shallow vagina ending in cul-de-sac; a second effort revealed another vagina, normally connected with the uterus, the cervix of which was hard, well-formed and healthy. Examination of the cul-de-sac caused great pain, but he was able to diagnose a rupture in the septum as the probable cause of the peritonitis.

Several cases of non-formation of the vagina with more or less normal uterus, are reported: one by Flammarion,[47] of congenital absence of vagina, and non-perforation of cervix. The patient, aged 23, had never menstruated, but suffered from abdominal pain at each epoch corresponding to the menstrual period. Upon examination, the vagina was found to be absent. The septum between the vagina and urethra was very thin. The accumulation of liquid in the uterus had led to the formation of an abdominal tumor, upon which it was deemed expedient to operate. The tissues between the bladder and rectum were dissected up, and the cervix pierced with a trocar, when a considerable quantity of dark fluid was drawn off. Death took place 20 days after the operation from septic peritonitis. Another, by Placencia,[48] of a patient, aged 26, also suffering from an abdominal tumor. The vagina was completely obstructed by an elastic membrane, which yielded upon pressure. Conformation of external genitals and mammæ normal. Operation for the removal of the tumor

per perineum successful. The tumor consisted of rudimentary ovary and uterus, with complete Fallopian tube.

Polaillon[49] details the result of an examination upon a young woman of 18, in whom examination revealed entire absence of vagina. The menstruation having become intensely painful, a transverse incision was made into the perineum, through which the tissues were lacerated for a considerable distance. Perforation of the impervious os of the uterus was accomplished and an ounce of black liquid drawn off. Patient made a good recovery.

Rothemberg[50] describes seven cases of malformation of the female genitalia, among which were three cases of atresia vaginalis. In one case the vagina for its lower two-thirds was double, and complicated by an hæmatocolpus and hæmatometra. The other four were rudimentary developments of uterus, ovaries and vagina.

Anomalies of Clitoris.—Friedinger[51] describes a case in which the clitoris was two inches in length and had a well developed prepuce. The glans was perforated and connected with the urethra, from which more or less urine passed. The normal opening of the urethra, however, seemed to be in its usual place, somewhat posteriorly. The clitoris in this case represented a membranous body, which hung between the labia majora and minora, more or less blocking the vaginal orifice.

Heinzelman,[52] of Munich, gives an account of a case somewhat similar to the preceding one, in a patient aged 13, external examination of genitals revealing an organ somewhat resembling a penis, situated underneath the mons veneris. It was 3 cm. long and 1½ cm. thick, with naked glans, and well-developed prepuce. The organ was not permeable, the true orificium urethræ being situated underneath, fully 2 cm. from the end.

Malformations of the Male Urethra.—Voituriez,[53] of Lille, in an able article on the malformations of the male urethra, prefaces his remarks with the method of its development, a study of which is essential to a complete understanding of the anomalies that arise in its formation. Having established the data of the development of the urethra, Voituriez concludes that it is easy to apply the pathogeny upon the ground of an arrest of genesis, the marked differences in the origin of the different portions of the canal accounting for the anomalies observed. He says that the law of Costé, "The more retarded the formation of an organ, the greater

the danger of an arrest in development," which is so aptly applied in the explanation of malformations in general, is especially true of the urethra, as by far the larger percentage of malformations occur in the balanic region, which is the last to be developed.

Voituriez relates the following interesting case as an example of balano-hypospadias: Patient aged 29. Good constitution. The penis well developed, also the testicles. The glans uncovered, the prepuce being reduced to a mere fold upon the superior body. The urethra opens upon the base of the glans, from which point a vertical fissure extends to the summit of that body, representing the entire balanic portion of the urethra. The frenum is absent.

Other rare anomalies of the meatus are recorded, among them one in which it resembled the figure 8 (Yarjavoy); another in which the meatus had four lips (Malgaigne). This last variety is to be explained by a double formative process in the balanic portion. In some instances, hypospadias coincides with the persistence of the meatus at its normal place, and even an independent formation of the balanic channel. Several cases illustrating these varieties of malformation are related by Voituriez, as follow:—

Imperforation of meatus at base of glans, with punctiform orifice. Patient, aged 5 years, otherwise healthy. Normal meatus imperforate. Micturition was accomplished by means of the false orifice. Exploration of the urethra by means of the filiform bougie through the false opening showed the cavernous portion of the urethra to be normal in calibre, but when turned toward the meatus in the balanic portion, it was immediately arrested. The glans, with its urethra, was normally developed, with the exception of imperforation of the meatus, and terminated in a cul-de-sac, the spongious and balanic portion having failed to unite. The urethral canal in the body of the organ failed to connect with that of the balanic portion, and a false opening was thus produced.

Cases of like nature have been recorded by Dionis, Sabbatier, and Berard, who have tried to explain the false meatus as an imperforation of the normal meatus, with consequent rupture of the urethra (congenital fistula) by pressure of the stream of urine. The correctness of this hypothesis, although controverted by Voituriez, is apparently borne out by the following case reported by Tucker,[54] of San Augustine, Texas: An infant of three months, who had not passed water since birth, seemed to be in great distress,

fretting and crying constantly; but the child was not presented for examination, however, until four months later, at age of seven months, relief in the mean time having been obtained by rupture of the urethra into the rectum. At the examination, Tucker found an imperforate and adherent prepuce, upon which he operated with the result of forming a normal urethra through which urine passed almost immediately. The fistulous opening in the rectum closed, or at least the mother observed no urine passing by it.

Retro-balanic Hypospadia.—(Voituriez.)—Existence of the normal meatus with an independent balanic urethra. Patient æt. 26. Penis and testicles normally developed. Meatus permeable, balanic urethra ending in a cul-de-sac. The false orifice situated at base of the glans. Genital groove remained open at anterior extremity, giving rise to an hypospadias. The meatus, however, was normally located and connected by a long canal with the cul-de-sac. This case demonstrates the independent formation of the balanic portion.

Complete Balanic Fissure.—Orifice of urethra at base of glans. (Voituriez.) Patient aged 43. Married and the father of three children. Micturition and ejaculation easily performed. The glans was split into two halves on the median line by a fissure which began at the base of the organ. The urethra was of normal calibre. Through a diverticulum connected with the fissure a sound could be passed into a cul-de-sac to the depth of 2½ cm.,—this latter being an attempt on the part of nature to form the balanic portion of the urethra, which failed to connect with the spongious portion.

Some authors have spoken of a double urethra in a single organ. Voituriez says that according to the best embryological data such a condition can not exist; but that cases like those above cited, of hypospadia with persistence of the meatus and balanic portion of the urethra, have been mistaken by them for a double urethra. Several good authorities, however, take exception to this view. The following case, presented by Prof. Lipp[55] before the Verein der Aerzte in Steiermark, seems to establish the possibility of a double urethra in a single organ. Patient aged 25. Two openings in the penis. The false urethra admitted a No. 17 sound which could be introduced as far as the symphysis pubis. Gonorrhœal discharge from both urethras.

Dugald Mitchell[56] also reports the case of a child at birth in which the margins of the urethral groove were still well marked on

the under side of the organ, but had failed to unite so as to form the urethral canal. The urine, as a consequence, issued from the primitive urethral orifice that opened in a vaginal-like circular depression about the size of a goose-quill, situated at the root of the penis. The penis was considerably shrunken. The testicles had descended and were located in what appeared to be the labia majora, by reason of the separation of the scrotum into two parts.

Hermaphroditismus.—Pozzi and Grattery[57] publish a very interesting case of pseudo-hermaphroditismus, or perineal hypospadias, in a patient dying at the age of 69, of peritonitis. The individual had always passed for a female. The condition of the outer genital organs is exceedingly well shown in the accompanying cut (Fig. 13), and renders a lengthy description unnecessary.

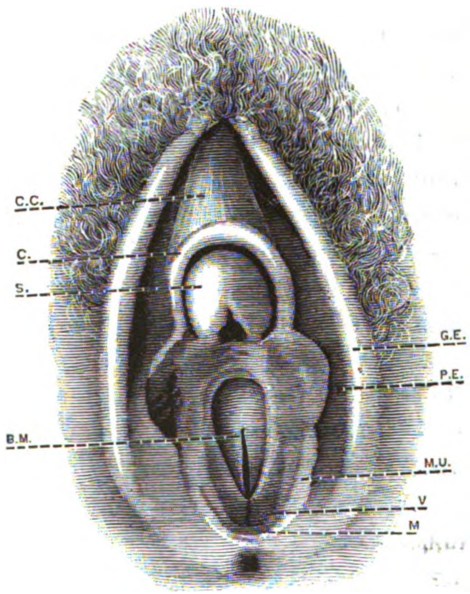

FIG. 13—G.E., LABIA MAJORA; P.E., LABIA MINORA; M.U., MEATUS URINARIUS; V., INTROITUS VAGINÆ; B.M., FRENUM; M., FOURCHETTE; S, GLANS; C, PREPUCE; C.C., CORPORA CAVERNOSA.—(*Le Progres Méd.*)

The glans (s) was conical in form, 12 mm. in breadth. Circumference at base 43 mm. Superior border thin and curved; the inferior border represents the fossa navicularis, which is continuous with the inferior fossa, only separated from it by a thin membrane. On either side of the meatus urinarius, two slight depressions 15 mm. in depth, into which a filiform bougie could be introduced. These were probably the orifices of the glands of Cowper. The testicles varied considerably in size, the left being situated in the inguinal region and the right, much larger than the left, in the labia majora, and encroaching upon the lumen of the vagina.

W. West,[58] Belleville, Ills., presents a case of the above, complicated with hydrocephalus and a webbed condition of the fingers and toes. It was the seventh child, all the previous

children being healthy. The penis was fairly well developed; scrotum rudimentary; testicles not descended; a small protuberance underneath the penis was divided into two lobes by a fissure from which urine issued when pressure was made upon the bladder. The middle and ring finger of the right hand were fully webbed, while the same fingers of the left hand were only partially united. The second and third toes of both feet were entirely webbed.

A case of hermaphroditismus[59] was also presented by M. Polaillon to the Paris Obstetrical and Gynecological Society. The patient showed many features common to the female sex: mons veneris well developed, and two lateral folds of skin below simulating the labia majora and forming a fourchette. The penis was 4 cm. in length, ending in a glans covered with a prepuce. The meatus urinarius was located in the centre of the glans. Beneath the penis an empty scrotum was found, and behind this a depression having somewhat the appearance of a vulva. No uterus, ovaries or testicles being discoverable, the case was therefore an hermaphroditismus of the neuter gender.

Cryptorchidismus.—Morpau,[60] of Tours, France, reported observations on a supposed girl of 12 years. She dressed as a female, but looked like a male. Examination revealed a flat pubis, hairs dark and abundant, pelvis narrow, abdomen hard and prominent. There was a penis with marked hypospadias. No scrotum was present, but on each side of the superior wall of the canal there was a small and thin labium, entirely cutaneous. The meatus urinarius was below the root of the penis. Rectal examination revealed a small, soft prostate. No testicles could be found.

An interesting case is reported by Faivre,[61] of a peddler, 21 years old, who was admitted to the Hospital of St. André, Bordeaux. The penis was about the size of a little finger and five centimetres long. The scrotum was not larger than that of a child five years old, and contained but a small quantity of pigment. It was also destitute of hairs, and presented on the median line a raphé resembling a membranous cord. The testicles and the epididymis were not to be found, either in the scrotum or elsewhere. On the left side, by feeling lightly, a thin cord could be distinguished. Rectal examination showed a complete absence of the prostate, the finger easily reached the base of the bladder, and even as far as the symphysis pubis. He had no venereal desires,

though he had lived with a woman for about six years. The penis was easily introduced into the vagina, but no spermatic fluid was ejaculated. He confessed to having had a true urethritis. From the above description, Faivre concluded that it was a case of congenital, bilateral cryptorchidism.

In the case reported by Parham,[62] of webbed fingers and toes, the patient was cryptorchitidic. The penis was diminutive with dorsal elongation of the prepuce and a slight hypospadias.

Dr. M. F. Podesta[63] describes a case of a supposed woman (Italian), who presented upon examination a well-developed penis, having at its base two folds of skin, covered with hair, resembling the labia majora. The prepuce covered the glans; the meatus urinarius was situated at the base of the glans, forming a hypospadias. There were no traces of uterus or ovaries to be discovered by rectal examination. This was evidently a case of cryptorchidismus, and the supposed labia was the divided scrotum.

ANOMALIES OF THE HEART, VASCULAR AND MUSCULAR SYSTEMS.

The Heart.—Bury[64] reports an interesting case of congenital atresia of the conus arteriosus, with incomplete formation of the septum ventriculorum, and the aorta necessarily arising from the right ventricle. In giving the etiology of the case, Bury presumed that before the seventh week some slight obstruction existed at the origin of the pulmonary artery, and gave rise to the hypertrophy of the right ventricle. The increased pressure maintained the communication between the ventricles and deflected the septum toward the left side. The aorta would naturally grow into communication with the right ventricle and the increased work would give rise to further hypertrophy.

Hayden,[65] of Evansville, Ind., briefly records a case of cardiac anomaly, in which the heart was considerably enlarged, with marked hypertrophy of the walls of the ventricle. The *foramen ovale* was still pervious. A foramen one-half inch in diameter united the right and left ventricles. The pulmonary artery arose from both ventricles, being divided in the wall of the heart into two branches, one terminating in either ventricle. The aorta rose normally from the left ventricle. The pulmonary veins emptied into the left auricle, which, with the right, was slightly hypertrophied.

A rare case of malformed heart, of congenital origin, was observed at the Columbian University at Washington. Lungs and the other abdominal viscera were normal. The heart, however, possessed only three cavities, two auricles and a ventricle. The aorta sprang from the ventricle. Immediately in front of the aorta a second vessel arose, which bifurcated within eight millimetres from its origin. Dr. Lamb, of the Army Medical Museum, considered it to be the pulmonary artery. The left auricle was much larger than the right; the foramen of Botal was pervious, admitting the tip of a little finger. The position of the tricuspid valve was occupied by a ring of fibrous tissue. A small pouch-like depression marked the position of the rudimentary right ventricle.

Aorta.—Dr. Boenning,[66] of Philadelphia, reports a curious anomaly: entire absence of the arch of the aorta. Two vessels arose from the left ventricle, one of which supplied the upper extremities, and the other became the thoracic and abdominal aorta.

Ledwich[67] reported a case of absence of the internal iliac artery in a male subject. The aorta bifurcated normally to form the two common iliac arteries. The left branch, however, failed to subdivide into the external and internal iliacs, but continued as a single vessel as far as the femoral. Its course was downward and outward over the psoas muscle for three inches. It then made a sharp angle and passed inward over the ilio-pectineal line to enter the pelvis.

Anomalous Division of the Brachial Artery.—Walters[68] describes an irregularity in the above named artery observed by him in a male subject. Instead of bifurcating at the bend of the elbow, it passed downward and slightly outward beneath the pronator teres, at which point it divided into the radial, ulnar, and inter-osseous. The last two mentioned occupied their normal relations; the radial, however, was covered by the pronator teres muscle. The recurrent radial arose directly from the brachial and passed over the tendon of the triceps.

Dr. Weinlechner[69] reports a very interesting case of an anomalous formation of the circle of Willis. The internal carotid artery gave origin to the posterior cerebral artery, as well as to the middle and anterior cerebral. As a result, the vertebral artery was very small. The basilar branch was also anomalous, and gave rise to the anterior and posterior arteries of the cerebellum. The

anastomosis between the posterior cerebral arteries of the cerebellum was very slight, the right being filiform in size.

Imperforation of Œsophagus.—M. Vincent[70] records a case in which the pharynx ended in a cul-de-sac. The œsophagus opened into the trachea by a very narrow orifice at about the third cartilaginous ring.

ANOMALIES OF THE EXTREMITIES, ETC.

As an example of excessive development, the following case is cited by Grandin,[71] of New York, occurring in a child 13 months old: "The upper arm of the right side consisted of two humeri, each articulating with a radius and an ulna. Between the radius and ulna was a third radius and ulna, possibly also articulating with the lower of the two humeri, the arm being semi-pronated. There were three hands, the upper had four fingers and one thumb, the latter always contracted, showing absence of the extensor muscle, and on its ulnar side two rudimentary fingers. The middle hand had four fingers, always contracted, the thumb lacking; the third hand had five fingers. Thus the child possessed on the right side two humeri, three radii, three ulnæ, three hands, with a total of fourteen perfect and two rudimentary fingers. The hand resembled a monstrous crab more than any thing else. Each hand could be moved separately. In regard to heredity, the father's aunt had two thumbs on each hand, and another relative, still on the father's side, had some peculiarity in the joints of one hand. The child's brother had a rudimentary tail, so to speak, in the shape of a coccyx projecting at least one inch."

Dr. Hartley[72] also reports a case of supernumerary arm on the right side in a boy ten years old. The scapula of the extra member, however, was wanting. The parents were healthy and non-consanguineous. Still, of the other children, one had a mole, another a Pott's disease, and a third showed the remains of a spina bifida.

An interesting case from France[73] shows degenerative hereditary taint extending through five generations. The first malformation in the family occurred on the male side of the house, in a man born in 1752, with six toes on one foot. A son presented a similar deformity; and a daughter, who was normally developed, gave birth to a son who showed the same deformity as

his grandfather. The other seven children were normally formed. One of the sons, however, had two daughters, one of whom had six fingers on each hand, and the other had the same number of fingers and six toes on each foot. The latter daughter had three children, including a son doubly deformed like the mother, and one with only the hands abnormal. One of the daughters of the fourth generation, with the feet only effected, gave birth to children with various malformations in the same direction.

Dr. Kurnan reports additional cases where the peculiarity was found in four generations of Norwegian paranoiacs and was unilateral. As has recently been shown, generations of six-fingered people are numerous among the lowest African tribes.

Wolff,[74] of Berlin, relates the history of a family in which three persons presented polydactylie. The extra members were tolerably well formed, with fairly developed nails. The hereditary taint extended through two generations, from father to son and daughter, and from son to daughter.

Parker and Robinson,[75] at the Clinical Society of London, read notes on a case of congenital deformity of the hands and feet, in a child 3½ years of age, upon which they operated successfully, where the foot was cleft at its anterior portion. The great and second toes were united and the three outer toes were also united to form one monstrous "little" toe. The hereditary taint was traced from a grandmother through three generations in thirty-six lineal descendants affecting the female side of the family.

Fillenbaum,[77] of Vienna, reports a case of supernumerary thumb, in which the extra member articulated with the metacarpus, and could be moved with ease.

Parham,[79] of the New Orleans Charity Hospital, cites an interesting case of congenital deformity. The fingers of each hand were united by a thick web of skin by which the hands were held in a semiflexed position. There were more nails than fingers. The feet were also deformed, but showed the markings, simply shallow grooves, for seven toes on the right and eight on the left foot. The line of nails was continuous, although thinner on the webbed portion. The feet were much broader at the toes than normal.

Absence of the extremities is due to an arrest of development or intra-uterine amputation. We quote the following examples:—

Amelus.—A Hindoo woman, aged 40, reported by Curran,[78] illustrates an arrest in development. The slight protuberance dependent from the cicatrix of the humerus and shoulder joint on the left side, at the time of the examination, and the one which had existed on the right side, but which had spontaneously fallen off when the patient was 10 years of age, may be regarded as the condition of the fœtal arms at three months, at which time development was arrested.

Abrachius.—An example of intra-uterine amputation of the forearm is recorded by Street.[79] The forearm was missing from a point one inch below the elbow. The cicatrix was very small, being $\frac{3}{4}$ inch in length, and the skin, considerably puckered around it, was not adherent to the deeper parts. The bones of the forearm could be distinctly felt, the olecranon process being normal in size. The history of the case revealed no hereditary taint. Berry Hart,[80] presented the case of a man who was without the lower half of one of his arms, and whose child was born with a similar defect.

Partial Abrachia.—Neale[81] reports a very interesting case of a small, imperfectly developed child. The left arm was represented by a normal humerus; the forearm, however, was malformed. The radius and ulna were illy formed and the elbow joint ankylosed. The hand terminated in two webbed fingers, with normal nails, and a freely movable thumb. The right arm and forearm were wanting, a formation resembling an aborted hand being observed, attached to the shoulder. It was somewhat flexible. The fingers possessed no nails. The appendage resembled the flap of a seal more than a human hand. It was hardly considered by Dr. Neale as a case of ectromelus.

Ectromelus.—Hirst,[82] reports a case of a fœtus expelled in the fifth month, in which there was a numerical diminution in the extremities, consisting in the absence of the left femur, and four toes of the left foot, and which he classified as an ectromelic monster.

Apus.—Myschkin[83] describes an embryo which, with the placenta, weighed only 5 pounds. The upper extremities were well formed; the body wedge shaped; the lower extremities were absent. The abdominal contents depended from the lower portion of the abdominal cavity, the walls of which were wanting. A condition of kyphoscoliosus and spina bifida also existed.

Congenital Absence of Pectoral Muscle.—Maguire[84] presented

to the London Harveian Society, a case of absence of the pectoral muscle in a boy of nine. The pectoralis minor was entirely absent, and only the clavicular portion of the pectoralis major was present. The movements of the arms were normal, no deformity of the shoulder existing. He also met with a similar case recently in which there was entire absence of both pectoral muscles.

Congenital Defects of Eye and Ear.—Snell[85] relates the case of a woman of 26, who exhibited in each palpebral fissure, at the external commissure, a tumor as large as a hazelnut. They projected between the eyelids, resting against the globe and extending into the orbit. The conjunctival covering of each was thickened where most exposed, and minute hairs grew upon their surfaces. The tumors were movable and free from the eyeball. In the right upper eyelid there was an incomplete coloboma terminating in a large nodule. It involved the entire thickness of the eyelid, and the union of the portions above, where it ended, was indicated by a sort of raphé.

The external ear on the left side was for the most part absent. No auditory meatus could be seen or felt. The upper part of the auricle was represented by a cartilaginous ridge, and at the lower end, sloping backward, was a softer and more fleshy portion like a piece of lobule. A watch was heard well on contact. The mastoid was very flat, but on the opposite side there was no prominence. The right external ear was normal, except that a reddish-looking piece of skin, about $\frac{3}{4}$ of an inch long, projected outward from the tragus, close to the base. A small projection also extended from the tragus over the meatus. The whole of the right side of the face was smaller than the left.

In a second case, a boy of 15, Snell found an absence of the greater part of left external ear. The auricle was represented by little more than its external vein: there was no tragus, antitragus or any other cartilaginous portion, nor could any cartilage be felt beneath the skin. In a third case, the cartilaginous portion of the right ear was practically absent, and the external ear was represented by little else than the lobule. The external auditory meatus was wanting, and the side of the face was smaller than the left. The tick of a watch could be heard.

Absence of Thumbs.—Adam,[86] of Königsberg, reports a case of malformation in an 8 months' fœtus, in which the bones of the

arm, inferior maxilla, and the muscles of the ear were diminutive in size, and the thumbs and small bones of the ear entirely absent.

Absence of Nails.—A case[87] is reported from the district of St. Marguerite, France, in which a hereditary absence of nails occurs in a family of several members, both fingers and toes being marked by the deformity. This is only the second case thus far observed, the first being at the Anatomical Museum of Berlin, and recorded by Dr. Bleck. In a verbal communication Dr. Sajous reports three cases of total absence of nails in members of one family.

Arm in Thoracic Cavity.—Becker,[88] of Leipzig, reports a singular and very rare anomaly of an arm enclosed in the thoracic cavity of a child otherwise normally developed. Only the shoulder of the left arm was visible. The arm, very much shorter than the other, occupied a diagonal position directed toward the right hypochondriac region. The hand was more or less deformed, one finger being absent and also the nail of the thumb. The opening in the thoracic cavity through which the arm penetrated was located between the third and fifth rib, and extended to within 5 mm. of the edge of the sternum.

Polymastia.—Five cases of polymastia have been recorded during the past year. Christie[89] gave an account of a case in which, on the fourth day after confinement, he discovered milk pouring from the axillæ of the patient. An isolated gland, the size of an English walnut, was the source of the supply. He had not observed any such condition in former confinements of this patient. A unique case of polymastia is reported from Warsaw by M. Bieganski,[90] in which four supernumary nipples were discovered, two in either axilla and one under either breast, and one on each side of either normal nipples, making ten in all. Those in the axilla exuded milk while the child was nursing, and from all milk could be pressed. Another curious feature of the case was that these supernumerary glands were not fully developed until the second pregnancy. Holton,[92] of Brooklyn, relates a third case where the supplementary glands located in either axilla, appeared at each confinement, and gave rise to very considerable inconvenience to the patient. Milk could be pressed from both. Two cases are reported from Calcutta,[91] where supplementary breasts were found in the axillæ of each,—in one case appearing in the first pregnancy, and in the other in the second.

MONSTROSITIES.

Blackshear,[94] of Macon, Georgia, reports a case of an anencephalus weighing three pounds. The top of the head was flattened and the eyes and ears were situated on a line with the upper border. The neck was absent, the chin being united to the chest. The thumb of the right hand turned backward. The left arm presented a condition of partial abrachius, the forearm being missing and terminating at the elbow in an aborted hand with only three fingers. The toes were also deformed. The spinal column was very broad, but not bifid. The front and parietal bones lay flat upon the base of the cranium, with no intervening brain substance. The occipital bone was absent. The spinal cord, as well as the brain, was entirely wanting, no spinal canal having been formed. Ossification had not occurred in any of the bones of the spinal column, pelvis, clavicle, or ribs.

West,[95] of Belleville, Ill., recounts a case of an anencephalic infant, in which the family history on the mother's side showed hereditary taint, a child having been born with a face like a bat. The infant in question had no cerebral mass. The roof of orbit absent. Cerebellum normal, as well as all the animal functions; body symmetrically formed, 18 inches in length; weight 10 pounds.

Brown[96] reports two instances of anencephalia born to the same parents in succeeding years. In the first, a large soft tumor was to be seen, around the edges of which the parietal bones, soft and gelatinous, could be felt. The tumor was covered with skin and presented a luxuriant growth of hair. The occipital bone, together with several of the superior vertebra, were absent, so that the tumor extended down the back for a considerable distance. The child drew a few breaths and died. At a second confinement another deformed child was delivered, still-born, at 8 months. The tumor was not as large as in the first instance. The occipital bone was again absent, but the vertebræ were fully formed. Pressure upon the mass produced tetanic spasms. Hydramnios was also present.

Burr[97] presented to the Chicago Medical Society a case of a full term anencephalous fœtus, normally developed with the exception of a spina bifida.

Cordes,[98] of Geneva, reports a case in which the cranial vault

was represented by a fibrous membrane that became tense when the child cried or made any effort. Large veins crossed the surface of membrane, which also became swollen on slight exertion. The cerebral substance, covered only by the arachnoid and pia-mater, presented hernia-like through an opening in the fibrous covering the size of a five shilling piece. The dura-mater was perforated, and the gray surface of the brain could be seen through the other membrane. Face, mouth, tongue and maxillary bones normal.

Duncan[99] relates an interesting case of anencephalus with multiple deformity. The frontal and parietal bones were absent, and the occipital and temporal bones presented only in a rudimentary state. The brain cavity was divided anterior-posteriorly into two lobes, the right of which was covered with a fair growth of hair. The left was bare and the brain substance was enclosed by a thin membrane through which the pulsation of the vessels could be observed. The eyes resembled those of a frog.

Justice[100] adds another case, in which the occipital bone and skin were entirely absent. The brain was covered by the dura-mater. Double hare-lip and cleft palate existed. The left lobe of the liver was visible through an opening in the parietal wall of the abdomen, three inches in diameter, situated around the umbilical cord. No evidence of sexual development. Imperforate anus existed.

Thompson[101] reports an anencephalous monster whose mother he had attended at full term. The child was fully developed in every way except for the entire absence of the cranial vault, with the contents of the brain cavity. Smith[102] exhibited to the Academy of Medicine in Ireland a child affected with encephalocele. The child measured 21 inches in length at birth, and weighed 11 pounds.

Westmoreland[103] presented to the Georgia State Medical Society a case of a so-called double-headed boy. The second head was situated at the lower extremity of the spinal column, where the well-marked nose, mouth and eyes were to be seen. The tumor or growth was covered, with the exception of the face, with long curls. Suppuration supervening, operation was performed for its removal, which also included the coccyx and sacrum. Dissection of the growth revealed well-marked cranial bones, with what was supposed to be the dura-mater, but no brain substance.

Cyclocephalus.—Blet[104] relates an unusual case of cyclopism in a human fœtus, and advances the opinion that it might be

classed with the cyclocephalians of the rhinocephalic order. A single eye occupied the median line of the face and was formed by the union of four eyelids, the eyeball being absent. The nose was represented by a cylindrical horn or trunk, 2½ cm. in length. Mouth was very small. The fœtus presented in addition a double talipes varus, was cryptorchidic with rudimentary penis. The mother had previously borne two healthy and well-formed children. No cause for the malformation could be suggested by the parents.

Hodges,[105] of Bury St. Edmunds, reports a cyclocephalic monster. The single, but perfectly formed eye was situated in the median line, at the root of the imperfectly formed nose. The latter

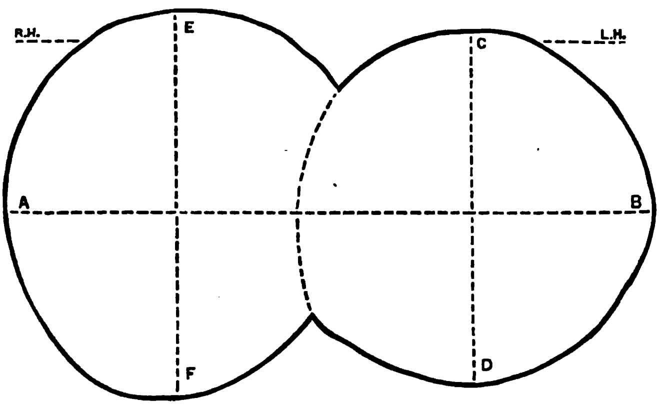

FIG. 19.—DICEPHALUS.—(*Edinburgh Med. Journal.*)

organ was destitute of nasal bones and appendages. The floor seemed to be formed by the superior maxillary process.

Dr. Ecklund, Corresponding Editor, Copenhagen, sends an account of an interesting case of skaphocephalus in a man 59 years old. The head was much compressed laterally, causing a crest-like projection along the line of the longitudinal sinus; hence the name. The occiput but was slightly developed, the forehead however, large. The principal measurements of the head were: greatest longitudinal diameter, 190 cm.; greatest transverse diameter, 123 cm.; circumference 520 cm. Ecklund considered this the result of premature synostosis of the sagittal suture.

Dicephalus Dibrachius.—Phillips,[106] in an interesting article on dicephalic monsters, gives results he obtained in the dissection of a case. The right head was encroached upon in its inner surface by the left head, as shown in above diagram. Greatest length of the

two fœtal heads from A-B was $6\frac{5}{8}$ in.; the anterior-posterior diameter of the left head was $3\frac{5}{8}$ in., and the right 4 in. The sternum was single, but much broader than normal. The two necks were of equal size and quite separate, and arose from the common shoulders. The spinal columns, however, were distinctly visible as far as the sacrum and their separate origin could be easily made out, although more or less fused together. The lower extremities were single and normal. The surface view of the

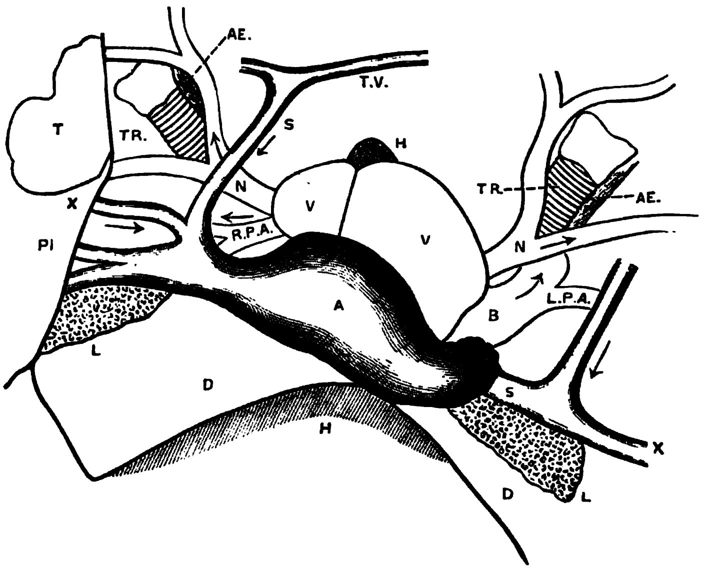

FIG. 20.—A, right auricle, stretching, with its appendix, across transversely, and receiving at its right extremity:—S_1, the superficial vein from right head; X_1, the subclavian vein from right arm; P_1, the pulmonary vein from right lung; and X, a common trunk formed by the deep jugular vein from the left head and the subclavian vein from the left arm. V_1, right portion of the common ventricle giving off:—N_1, the right innominate artery, dividing into subclavian and common carotid; R. P. A., the right pulmonary artery. V, left portion of the common ventricle giving off:—N, the left innominate artery, dividing like its fellow on the opposite side; B, the bulbus arteriosus, giving off a large left pulmonary artery (L. P. A.), and a smaller one to the inner lung of the left side. L_1, L, the bases of the right and left outer lungs. T, the right thymus gland. T R_1, T R, right and left trachea, with thyroid glands. AE_1, AE, right and left œsophagus. T. V., transverse vein running in the intercervical integument. H, liver with H_1, its adventitious lobe. D, upper surface of the diaphragm.—(*Edinburgh Med. Journal.*)

abdominal viscera upon section were seen to be normal. A thymus gland occupied the normal position at the base of each neck. The deeper view as shown by closer dissection is depicted in Fig. 20. The space between the two spinal columns was occupied by the inner lobes of the right and left lungs, into which the smaller bronchi were seen to penetrate. There were separate œsophagi entering the stomach by distinct openings. The heart, by reason of its two auricles and one ventricle, resembled the reptilian

heart. There existed a partial septum in the ventricle furnished with a spurious foramen ovale. The blood from the common vena cava, the right pulmonary vein and the common vein of the left head and upper extremity entered the right auricle, which latter communicated with the left by a foramen ovale and with the ventricle by a tricuspid valve. The innominate artery arose from the right side of the common ventricle and soon divided into the common carotid and subclavian, and a right pulmonary artery. The pulmonary vein of the left lung emptied into the left auricle, which communicated by a well-formed mitral valve with the left portion of the common ventricle. This compartment gave off (1) a left innominate that supplied the left head and upper extremities; (2) a bulbus arteriosus which, after giving origin to two left pulmonary arteries, curved downward and backward, becoming the aorta and followed a course parallel to the vena cava inferior.

Thoracopagus.—Wands[107] reports a case of thoracopagus in which both children, females, except for the area of union, were perfectly formed. There were two thoracic cavities, but only one abdominal. One placenta and one umbilical cord supplied both. It was divided for a short distance from the abdominal wall. A slight condition of ectopia abdominalis existed, and through the opening Dr. Wands was able to feel the liver, which was single and lay across the cavity. The bodies weighed 11 lbs., each was over 17 inches in length, and the two measured 16½ in. in circumference around the waist.

Van Henkelom[108] describes the anatomy of a double monster in the Döerhaave Laboratory, very similar to the above. The union, however, was by the thoraces as well as the abdomens: a single liver, triangular in form, with a sulcus in the centre, showed where the union had taken place. The heart was single, there were two stomachs and two duodena, united to a single jejunum. The ilium was double.

Herrgott[109] records a case of thoracopagus, of which the accompanying plate is a reproduction. Union was by the thoraces and abdomens. With the exception of a double hare-lip on one of the children, they were apparently well formed. Skibbe[110] reports a similar case in which one heart was hypertrophied, and the other defective, presenting a high grade of

stenosis of the tricuspid valve. The greater portion of the intestinal canal was common to both.

King,[111] of Clifton Springs, N. Y., read before the Edinburgh Medical Society the history of the obstetrics and dissection of a double monster. One child was nearly complete, being 19 inches in length, with a head of medium size. The second child seemed to transfix the first in the abdominal region, so that the two fœtuses faced each other. In each the thoracic organs were complete, the abdominal organs single. The second fœtus had only one leg with a double foot.

Thoracopagus Parasiticus.—Moulvi Zuhiroodeen Ahmed[112] reports a case of monstrosity, in which the pelvis and legs of a second female child were attached above the umbilicus of an otherwise well-formed female child.

Pygodidymus.—Ilott[113] relates an instance of this form of anomaly of a very peculiarly united pair of twins that could perhaps be said to come under this classification. They were normally developed below the umbilicus but were united by the sacral, vertebral and the iliac bones. A spina bifida existed at the point of union. The four inferior extremities were normal; the outer genital organs were common, but the internal ones consisted of a double vagina. No clitoris was to be seen. There was a single placenta and umbilical cord; the latter, however, divided, and supplied each child. There was also a single child born at the same time, weighing 4 lbs. The monster weighed 6 lbs. 13 oz.

Verco[114] describes a case of a fœtal monster that from the description we have failed to classify. It was about 6 inches long, 3½ broad, weighing one pound and one ounce. It was pear-shaped, and where the stalk should be were two diverging finger-shaped processes, one twice as long as the other. The lower two-thirds were quite smooth and rounded. The umbilical cord was situated in the median line at the junction of the upper and middle third; there was no evidence of any organs of sex. The upper third was divided into three unequal lobes in front,—the central one representing the head, the lateral lobes representing the limbs. No evidence was seen of any rudimentary eyes, nor any external opening of the urinary or intestinal systems.

Nansomia.—Machell[115] presented the dwarfed body of a fœtus

Burk&McFetridge,Lith.Phila.

Thoracopagus (Herrgott)

Annales de Gynécologie,

G Steinheil, Pub Paris

at 8 months. The head was larger than normal, but all the limbs were less than one-half the ordinary length. The bones were twisted and bent. Hydramnios was present, which may in some way account for the malformation. All the previous children had been large and healthy.

Exomphalismus.—Simpson[116] exhibited before the Edinburgh Obstetric Society a specimen of an exomphalic fœtus in which the whole contents of the abdominal cavity were outside the body, and called attention to several peculiar features in the case:—"(1) The labor was *premature.* (2) The *attitude* of the infant was peculiar. Instead of the usual anterior incurvation, the trunk curved backward and to the right side, so that the clubbed feet of the fœtus were close to the right side of the occiput. (3) There was a *malpresentation.* Instead of the head, the ventral mass with the left shoulder and side of the thorax were felt through the os. Out of fifteen such cases of exomphalos, presentation of the abdomen had been met with in thirteen. (4) The *delivery* had to be effected artificially by introducing the hand and laying hold of one of the lower limbs."

Ectopia Abdominale.—Hawkins[117] describes an eight months' fœtus with the following abnormalities. The umbilical cord was only 2½ in. in length. Ectopia abdominale was complete. The lining of the bladder was covered by meconium, the intestine opening into the bladder. There was no distinction between the large and small intestines. The penis was imperforate and rudimentary. It occupied a position above the imperfectly developed pubis, the lateral halves of which were united by a ligamentous band. The scrotum was divided and empty, the testicles undescended. A large cyst, filled with a clear fluid, was connected with the vertebral column. Both feet were clubbed. Hirigoyen,[118] of Bordeaux, presented a case of ectopia abdominale to the Society of Anatomy and Physiology.

Ectopia Vesicæ.—Shattock[119] gave an account of a case of ectopia vesicæ. A complete fissure of all the parts on the median line extended as far as the umbilicus, including the anterior wall of the bladder.

Gastrocele.—Matzdorff,[120] Berlin, in an inaugural address, gave the history of a case of gastrocele and ectopia abdominale. He accounted for the abnormality by a failure upon the part of the

abdominal wall to unite through some arrest in the development of the amnion and peritoneum.

Spina Bifida.—Sutton[121] gives a case of spina bifida occulta associated with scoliosis, talipes equino-varus of left foot, atresia ani, imperforate pharynx with communication between œsophagus and trachea, fibrous degeneration of the vermiform appendix, undue shortness of the cæcum, rectum ending in a cul-de-sac in the prostate, and a single kidney. Besides these many malformations, the spinal column showed marked abnormalities.

Foliaceous Fœtus.—Napier[122] gives a case where, confined in the same amniotic sac with a healthy, well-developed child, was an atrophied fœtus with which no trace of placental attachment could be found save slight thickening of the amnion in proximity of the dead fœtus,—probably an imperfectly formed placenta.

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DENTAL EMBRYOLOGY AND HISTOLOGY.

By W. XAVIER SUDDUTH, M.D., F.R.M.S.,

PHILADELPHIA

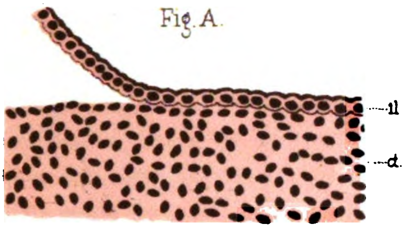
In previous writings the editor has spoken of the formation of the oral cavity as an infolding process, by which the external epithelium forms the mucous lining. The development does not begin strictly, as an indentation of the embryonic tissues, but approaches that end by outward growth of the buds or processes that constitute the maxillary arches. The first appearance of the development of the walls of the oral cavity is remarked about the twenty-fifth or twenty-eighth day of embryonic existence. The cavity is then bounded by the developing processes of the superior and inferior maxillæ and the frontal or incisive process. The inferior maxilla arises from the two lateral pharyngeal arches, which, growing downward and outward, unite in the median line. The superior maxilla arises by three points: the first pharyngeal arches upon either side of the face and the frontal prominence. The lateral buds grow outward and downward and attach themselves to the nasal process. The incisive process, developed from the frontal prominence, grows between the two ends of these lateral processes, thereby completing the superior maxillary arch. The roof of the mouth is formed by the development of the hard palate, which springs from the inner side of the two lateral processes of the superior maxillary arch. They unite in the median line, thus separating the nasal from the oral cavity.

These processes arise from the pharyngeal arches as solid buds, and are covered with the epiblastic layer, and hence, as a natural result, the epiblast comes to form the lining membrane of the oral cavity, and is analogous to and continuous with the epiblastic covering of the outer portion of the body.

The histological appearance of the tissues of the mucous membrane of the mouth of a serial line of porcine fœtuses may be seen in the accompanying lithographic plate, the figures of which

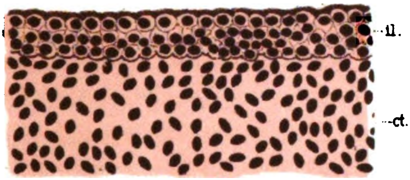
were made from photomicrographs taken from slides of the editor's own preparation. By reference to the plate it will be seen that there exists very little difference in form between the cells of the mesoblastic and epiblastic layers. Those of the epiblastic layer at this stage of development, il, are round, while those of the mesoblastic layer, seen at ct, are somewhat oval; the difference is not, however, marked. There has been no attempt upon the part of nature to differentiate a cell-body. The cell consists at this stage of development of round or slightly oval nuclei. The editor has failed in all his studies upon well-preserved embryonic tissue, either with the microscope or by photography, to differentiate such lines of division as are represented by most writers upon embryonal histology. The nuclei of the mesoblast lie imbedded in a bed of protoplasm, in which they are more or less irregularly distributed. The cells of the epiblastic layer are arranged in a parallel row, il; but as the tissues advance in age this regularity is more or less lost. Fig. B, il. If this occurred only in a few instances, the editor might be led to believe that he was mistaken; but in his study of embryology, extending over six years, during which period he has examined some hundreds of embryos, including among the different varieties of embryos studied beside human, rabbits, pigs, lambs, calves, dogs, cats, snakes, tadpoles, salamanders, eels, alligators, chicks, etc., he has never noticed any marked divergence from this rule. From these observations he is led to infer that the nucleus is the essential part of the cell, and that the cell-body is an after-product. The illustration, A, taken from the inferior maxilla of a fœtal pig, one centimetre in length, histologically compares with a human embryo of twenty-five days,—the stage when the formation of the oral cavity begins; also with a fœtal rabbit of twelve days. The embryonic connective cells at this age are composed of nucleated bioplasm, and present no indication as yet of fibrillation. They are thinly dispersed throughout the protoplasmic basement substance. They stain quite deeply with hæmatoxylin, and stand out in marked contrast to the basement substance when the latter is stained with eosin. In the specimen, A, of plate, the single layer of cells, il, constituting the entire thickness of the epiblast, has been artificially torn from the underlying mesoblastic tissue. Upon the surface of this layer a dark line appears, which consists of the condensed surface of the

Fig. A.



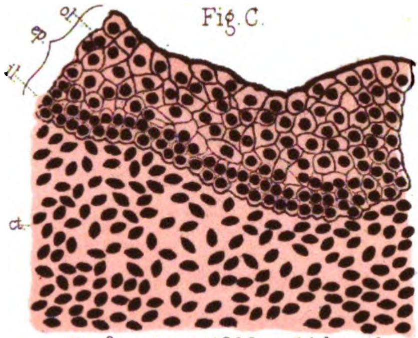
Porcine embryo 1cm. long il. infant layer of epithelium, ct. embryonal connective tissue X 200.

Fig. B.



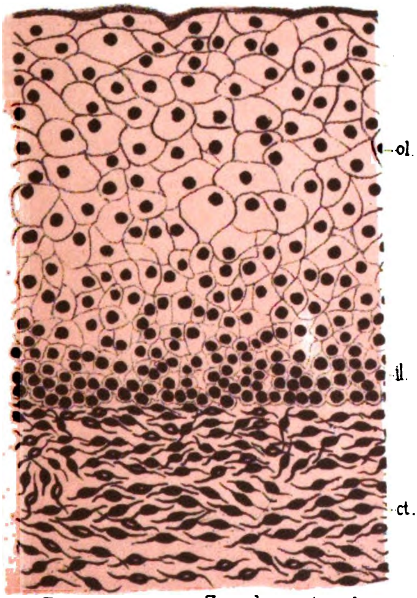
Porcine embryo 1½ cm. long il of epithelium ct. connective tissue X 200.

Fig. C.



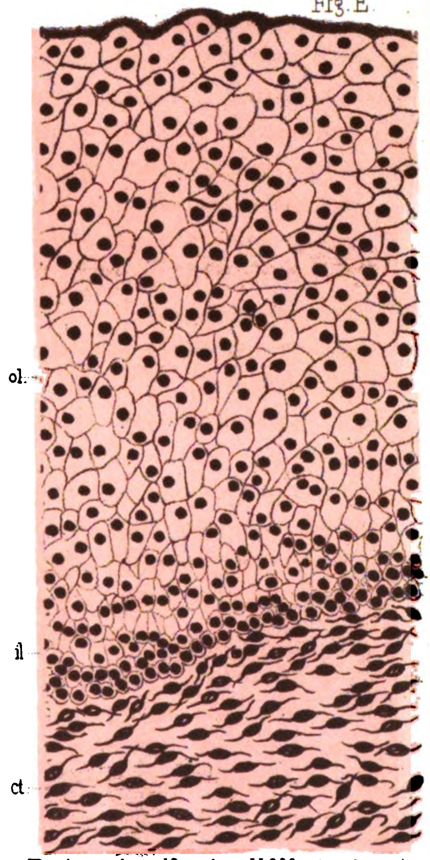
Pig. 3 cm. long X200-ep. thickened epiblast, il. infant layer ol. older layer. ct. embryonic connective tissue.

Fig. D.



Porcine embryo 7 cm. long ct. embryonic conective tissue, il. infant layer X 200 ol. older layer of epithelium

Fig. E.



Poreine embryo 10 cm. long X 200 - ct embryonic connective tissue. il. infant layer, ol. older layer of epithelium.

Burk & McFetridge Lith. Phila.

mass of protoplasm of which the embryo is made up (membrana prima of Hensen). Upon the under surface of the layer of cells another, but more dimly differentiated, line is also seen.

This has been called the basement membrane. While it is true that the epiblast separates quite readily from the mesoblast on this line, which latter adheres to the epiblast, yet most histologists hesitate to ascribe to it the characteristics of a membrane. The fact that it presents no hindrance to the infolding of the infant layer of the rete Malpighii in the processes of development of glands, hairs, enamel organ, and such other products of the epiblast militates against its membranous nature. Some have called it a structureless membrane; but it is hard to conceive of such a thing in the present status of histology as a structureless functionating body. In Fig. B the epiblastic layer, ep, is seen to have considerably thickened, and now consists of several layers of cells more or less irregularly arranged. The same superficial basement lines are presented as in the preceding figure. There is also a slight indication of a breaking up of the intercellular protoplasm into cell-bodies. This action is not well marked; however, lines of subdivision do here and there appear.

The embryonic connective tissue cells of the mesoblast have somewhat increased in size, and have assumed a more oval appearance than was noticed in the previous figure. The length of the embryo from which Fig. B was taken was one and a half centimetres; that of the next, Fig. C, three centimetres. In this a marked change in the epiblastic layer, ep, may be observed. It may now be divided into an *infant* and an *older* layer. These terms first appeared in English in Dr. Dean's translation of Legros' and Magitot's dental follicle. A comparative table of the terminology is shown on the following page.

The marked difference between the infant layer, il, and the older layer, ol, of the thickened epiblast, ep, is represented in Fig. C of plate. It will be plainly seen that the infant layer is here made up of two or more rows of nuclei, and that, as they are crowded up toward the surface by the development of other nuclei in the infant layer, the older nuclei collect around themselves more or less cell-body, which increases the nearer they approach the surface. These nuclei with their cell-body constitute the older layer of rete Malpighii.

		EMBRYONAL MUCOUS MEMBRANE.	MATURE MUCOUS MEMBRANE.	SKIN.	
MUCOUS MEMBRANE.	Epidermis.		Oldest layer.	Corneous layer.	
		Older layer.	Older layer.	Older layer.	RETE MALPIGHII.
		Infant layer.	Infant layer.	Infant layer.	
	BASEMENT MEMBRANE.				
	Dermis.	Embryonal connective tissue.	Papillary layer of membrana mucosæ.	Papillary layer of dermis.	
			Submucosæ.	Subdermis.	

The above diagram shows a comparison between the developing mucous membrane, mature mucous membrane, and skin. Between the epidermis and dermis lies the division line commonly called the "basement membrane."

At this stage of development, cellular activity is augmented throughout the entire infant layer. On the surface of the body it gives rise to the development of the dermal appendages by an infolding process, while the *band* with the cords for the temporary teeth is formed in the oral cavity. The processes are concomitant and the result of the same expression of cellular activity. No difference between the infant layer of the external skin and of the mucous membrane of the mouth can be made out by microscopic or chemical research. The directive impulse also appears to be of like nature, but the ends attained are very dissimilar. In each case there is dipping down of the infant layer into the subepithelial connective tissue. In some instances this results in the formation of hairs; in others, sebaceous or sudoriferous glands.

The cords of the temporary teeth in their incipiency very much resemble the processes for developing hairs: in fact, this resemblance is retained until the invagination of the bulbous cords is more or less complete. Just what is the character of the vital principle or directing agency that intervenes to determine the form of the resulting tissue we have never been able to ascertain. It is in all probability the law of heredity or reproduction of type as laid down in the first created of each species of life. This indwelling principle seems to have permeated even to the ultimate divisions of tissues, as we are able to discern them, viz., cells. Each and every individual cell has its function to perform, and the function of an organ is nothing more than the aggregated

activities of the individual cells which go to make up that organ. The "bourlet" or band for the temporary teeth deepens until it has reached the typal demands in the individual species in which it develops. Then from the inner side are given off at regular intervals the cords for the several temporary teeth, five on either side of the symphysis mentis in either jaw, twenty in all. These grow deeper into the substance of the jaw than did the band; and when they have reached the typal demands of growth, they become invaginated and the enamel organs for the several teeth are formed. We find the same procedure in the development of hairs. The buds, or processes which are given off from the infant layer for the formation of hairs, dip into the subepithelial tissues to varying depths in different species, as well as on different parts of the body of the same animal. Here again we find the likeness of the antitype, and the cells of that special portion of the infant layer obeying this apparent law of reproduction. The editor firmly believes that function may modify form in the adult; but that it has any noticeable influence on embryonic development he should hesitate to concede. Change in form, the result of adaptation to environment, operates to alter form through the impression given to the offspring at the time of fructification of the ovum. This impression is carried throughout the development of the embryo.

In Fig. C it will be seen that the older layer has become considerably thickened, but that the infant layer has not materially changed. The subepithelial connective tissue cells have become more markedly fibrillated, and the fibrous intercellular substance has also considerably increased. The cells in the enamel organs at this stage have become more or less stellate. The cells of the inner tunic in the region which will represent the apex of the tooth are assuming an elongated form, which gradually increases until they are columnar. This is plainly seen in the ameloblastic layer of the enamel organ in fœtal pigs ten centimetres in length: from one such the last figure, D, is taken. The infant layer of the rete Malpighii appears as in Fig. E; the older layer has thickened, and upon the surface the cells present a more or less elongated appearance,—thus forming the *oldest layer*, which compares to the corneous layer in the skin. The oldest layer of the mouth never presents such a character, however, because

it is continually bathed with the fluids of the mouth, and is thus prevented from becoming desiccated.

Dr. L. C. Ingersol, Keokuk, Iowa, in an original contribution to the ANNUAL, presents a unique drawing of the organic portions of a tooth, as shown in the accompanying figure. It represents a tooth from which all the lime salts, including the basement substance in which they were deposited, have been removed. Only the vitalized organic portions are left, consisting of the pulp and its appendages, with the dentinal processes and the cells found in the cementum. He seeks to show more clearly the intimate relation of the peripheral portions with the central nervous organ, the pulp, and thus to demonstrate the true character of the living organism upon which dentists are called to operate. He holds that we have become so accustomed to associating the fibrils of the odontoblasts with the dentine that we are apt to lose sight of their true character as prolongations of the pulp. He finds evidence of the correctness of these statements in our nomenclature,—"dentinal fibrils" and "sensitive dentine," etc. He continues: "It would seem from the language often used and from the methods of operating commended, that many in the profession believe that the life which the dental operator encounters in the dentine is the life solely of the dentine. He calls it sensitive dentine, and uses local anæsthetics and caustics with nonchalant freedom, backed by many professional recommendations, under the impression that he can suspend or even destroy all sensation in the dentine without affecting the life of the central organ of sensation. A glance at the illustration here given will convince any one of the fact that the life of the one cannot be tampered with without endangering the life of the other. The investigations of John Tomes and others who have made the dentine a subject of study, show that the so-called dentine fibrils are nerve fibrils,—that whatever else may surround them in the tubules, they contain at least a filament of nerve tissue with characteristic nerve functions."

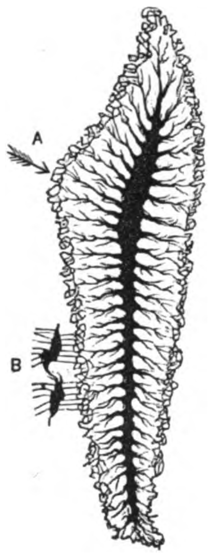


FIG. 1.—DENTAL GANGLION AND ITS PROCESSES (semi-diagrammatic).—A, Peripheral flexus of nerves; B, Bone cells with fibrillæ.

We are willing to admit that the fibrils perform the function of nerve tissue; but that true nerve filaments have ever been demonstrated we very much doubt. At the time when Tomes made his studies on the pulp, very little was known about terminal nerve fibrils as compared with what is now known; and no good authority can now be found who claims more than the power of "simulating the function of a nerve" for the dentinal fibrils. They arise from the odontoblasts, and these bodies are in intimate relations with the terminal fibrils of the main nerve trunks of the pulp. The fact that the true character of the method by which sensation is transmitted to the pulp is not known, does not in the least militate against the ingenuity of Dr. Ingersol's conception of the ganglionic nature of the pulp, with the fibrils performing the function of nervous tissue. He is inclined to accept the name nerve for pulp, as more befitting its character and function. He says: "The use of the word pulp dates back, no doubt, to a time before the true anatomy of the teeth had been discovered; when teeth were considered to be bones and the dental nerve,—and when brain and marrow were held to be the same kind of marrow-tissue. We might now, therefore, with as much propriety call the brain the 'cranial pulp' as to call the central organ of the tooth structure the 'dental pulp.'" Dr. Ingersol would favor the name dental ganglion as being more in keeping with its character and function. He holds that it is a "vesicular or corpuscular ganglion, rather than a tubular or fibrillous one. The nerve cells are multipolar, contributing nerve force, rather than acting as conductors of sensation. The physiological relations of the peripheral dental plexus to the dental ganglion are rendered more apparent in pathological conditions. When an operator is working in the periphery of the dentine the patient often insists that the instrument is in contact with the nerve. The pain is deep seated and so intense that he attributes it to the central nerve. The converging nerve fibres afford a direct connection with the dental ganglion, and pathological conditions of the periphery are readily communicated to the nerve centre.

"Sometimes a cavity is filled with a plug, not larger than a pin's head; but the operation proves so irritating to the peripheral nerve plexus, and the communication is so direct through the nerve fibrils to the nerve centre, that the dental ganglion dies as a result.

This has happened more than once in the mouth of a patient of the editor. From childhood up to womanhood her teeth have been so sensitive that the pain attending the operation of filling, whether the cavity was large or small, has been of the most excruciating character, and the result has been that many of the dental ganglia have died,—and from such teeth, too, as had no decay reaching within two or three lines of the chamber of the nerve.

"The illustration given also shows clearly the nature of the operation and what is required in extirpating the dental nerve. In the early days of dental science, when the anatomy and physiology of the teeth began to be studied with considerable zeal, many teeth ganglia were drawn out from extracted teeth for experiment, and the odontoblasts were found clinging by their processes to the dentinal walls. A very large proportion of the teeth treated by devitalizing and removing the ganglion are afterward more or less sensitive to severe pressure, on percussion,—at times, too tender for comfortable mastication. The cause undoubtedly lies in the fact that there is dead matter in the tubules of the dentine, if not in the canal of the tooth root, sufficient to affect unfavorably the cementum and the alveolo-dental membrane. These are facts that pathological science must recognize."

"The illustration also shows the intimate vital relation of the cementum to the dentine. We have represented two lacunal cells of the cementum in the drawing. The processes of these bone or cement cells enter and inoculate with the dentinal plexus of fibres on the periphery of the dentine. As the fibrillæ of the dental ganglion also inoculate with the plexus, it is evident that a tooth is not wholly dead when the ganglionic centre is destroyed. It derives life and support through the cementum and root membrane. There is no more difficult and delicate operation to be performed by dentists than that of extirpating the dental nerve. Extirpation means not simply devitalizing, but wholly getting rid of the devitalized tissue. It means to *kill*, and yet *save alive.* In conclusion, it must be remembered that from 25 to 38 per cent. of dentine is animal tissue, and in the operation of extirpation the dental operator has before him the problem as to how much of the dentine tissue may be devitalized without endangering the entire life of the tooth."

MICROSCOPIC STRUCTURE OF A HUMAN TOOTH.

C. H. Stowell, Ann Arbor, also represents the histological appearances of the living portion of a human tooth in a very fine plate. The continuity of the odontoblasts by means of their fibrils with the cementoblasts is well shown. He says that there are three separate forms of processes arising from each odontoblast: (1) those that unite it to its fellow; (2) those by which it forms its attachment to the connective tissue cells of the pulp proper; and (3) those that pass into the dentinal tubules, the dentinal fibrils. The latter branch as they approach the periphery of the dentine and finally unite with the cells of the granular layer and the cementoblasts. The tooth pulp,—upon the surface of which the odontoblasts lie, is composed of connective tissue, nucleated cells, blood-vessels and nerves. The latter end in non-medullated fibres most numerous upon the peripheral portions of the pulp in juxtaposition with the odontoblastic layer, some of the fibres passing between the cells of the latter, from which fact it has been inferred that they accompany the dentinal fibres to their termini. This fact has, however, never been demonstrated, although clinically many of us would like so to believe. This want of demonstration may be explained by our lack of knowledge as to how to stain nerve tissues that have been acted upon by the acids used for decalcifying the tooth substance.

Regarding the manner of the formation of the basis substance, in the development of dentine, Dr. R. R. Andrews, of Cambridge, Mass., in an original paper for the ANNUAL, says: "In the investigation of the formation of dentine with the higher powers of the microscope, from tissue which has been decalcified by the action of acids, there is found between the fully calcified tissue and the adjacent organic tissue, from which it is formed, a peculiar hyaline substance, which in its physical and chemical properties resembles the basis substance of bone, and has been described and named by Prof. Harting as calcoglobulin. As a rule, histologists have used this term in describing this tissue, found everywhere on the borderland of calcification. In an investigation extending over several months, the formation of this layer has interested me exceedingly. It is best studied in cross-sections of forming teeth where calcification has but just begun. In these sections we find against the

forming dentine globular masses of a different nature from the cells, of various shapes and sizes, and taking into their substance two or more of the formative cells. Globules which have enlarged, join together into masses forming buds, and reaching their typal width, expand laterally, meeting and coalescing with others. The odontoblasts which have not yet been taken into the substance of the buds, appear about twice the usual length and extend up into the layer of odontoblasts above. The buds of calcoglobulin stain in the same manner as the band of already formed dentine. Small globules, 'calcospherites,' are seen within the odontoblastic layer, of different sizes not as yet joined to the formed dentine: these have a glistening appearance when unstained, and cannot be mis-

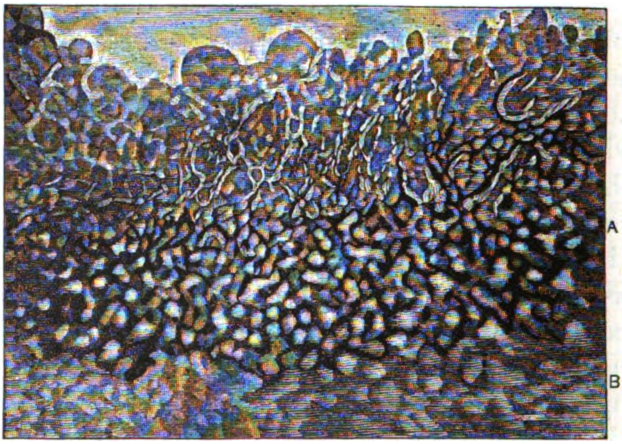


FIG. 2.—A, MASSES OF CALCOSPHERITES. B, FORMED DENTINE.

taken for cells. We sometimes see one of them forming between two of the odontoblasts, and oftentimes two or more small ones are joined together to form a larger one. By coalescing they thus form a layer about the width of the band of already calcified dentine, and also of the width of the band of formative cells, the odontoblasts. These facts seem to him to have much significance. He has not found the formation of this band so pronounced in dentine in a more advanced stage of calcification; but he never fails to find globules, or 'calcospherites,' in the layer of formative cells in tissue that has been carefully prepared." The theory has been recently advanced that the osteoblasts, in the formation of the jaw-bone, individually become calcospherites, whose outer surfaces take in the salts of lime, thus becoming the basis substance,—the

central portion remaining uncalcified, as the bone corpuscle; but Dr. Andrews observed that wherever these globules take the osteoblasts into their substance, the latter lose their individuality in the layer of tissue formed by the coalescence of these globular masses.

The aggregation of calcospherites is first seen on the edge of the newly calcified tissue, and is shown in Fig. 2, A. These globules are of different shape and size; and as they unite they form large masses or buds, as seen in Fig. 3. It will be seen in this illustration, a cross-section of the tooth of a calf, that a band of calcified tissue, C, has formed and another, B, is forming by the development of the buds of calcoglobulin into another layer. At the side of the central bud are clearly seen two of the cells which

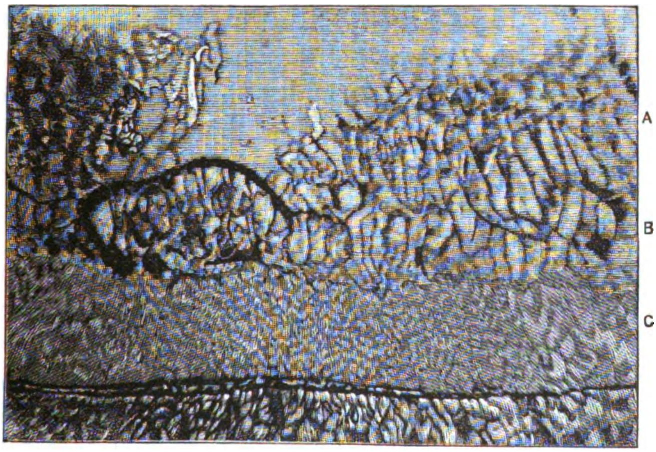


FIG. 3.—A, FORMING LAYER OF CALCOSPHERITES. B, FORMED LAYER. C, CALCIFIED LAYER OF DENTINE. D, OUTER LAYER ENAMEL.

are being enclosed by these globular growths, and apparently there are new layers of odontoblasts, A, forming just above.

In conclusion, the writer holds that the results of his investigation of the formation of this layer of calcoglobulin tend to confirm him in the theory he has already advanced, viz: That in the development of the dentine from the formative pulp there are other cells than the odontoblasts involved. These he considers only matrix formers, being membraneless masses of protoplasm that are square and ending abruptly against the former dentine, having apparently nothing to do with the formation of the dental fibrils; these being formed by another variety of cells that are pear-shaped, and which may be called the dentine corpuscles, and which have

the important function, namely: the nourishment of the matrix or basis substance of the dentine.

Allen, of New York, in an original paper written for the ANNUAL, considers the histology and physical characteristics of the neck of the tooth in their relation to failure of fillings at that point.

The term "neck," as used in his paper, applies to a space extending $\frac{1}{16}$ of an inch above and below the gingival margin, when the parts are healthy and normally developed. He maintains "that the tooth, taken as a whole, is the most composite organ in the body. Within the space designated as the neck we find the hardest as well as the softest of the calcified portions, enamel and cementum. The latter has a living connection with the underlying dentine and the cementum usually slightly overlaps the enamel at this point; but there is no union between the two, either vital or mechanical. Life force decreases from the dentine toward the enamel; but it increases from the dentine to the cementum and the peridentium. The enamel is non-sensitive, and non-vascular; the peridentium is both sensitive and vascular. The connection is vital. This fact cannot be too constantly kept in mind by the practitioner, for it has an important bearing on the success of dental operations, especially on those that encroach on the neck of the tooth. At this point the enamel is thinnest and most easily separated from the dentine. A filling in an approximal cavity, extending nearly to the free margin of the enamel, has a very insecure foundation. After the first pieces of gold have been placed in position, no satisfactory view of the floor of the cavity can be obtained, and the filling may be finished, polished, and the patient dismissed without a thought of danger or fear of bad results, and yet the filling be a poor one. The enamel edge may not chip off at once, and last through the operation and seem firm; but after a time it falls away, having been loosened during operation, or slightly separated from

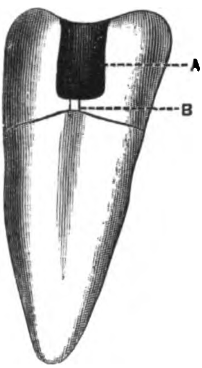


FIG. 4.—DIAGRAMMATIC VIEW OF FACE OF BICUSPID TOOTH, WITH FILLING IN SECTION.—A, Filling; B, Enamel edge with cracks.

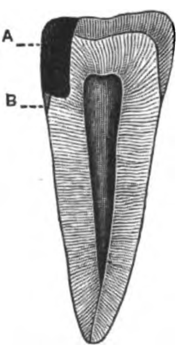


FIG. 5.—DIAGRAMMATIC SECTIONAL VIEW OF BICUSPID THROUGH FILLING, SHOWING WEDGE-SHAPE ENAMEL BORDER.—A, Filling; B, Enamel edge, wedge-shaped.

the dentine. Caries inevitably follows. In a so-called dead tooth the disorganization of the granular layer in the dentine subjacent to the enamel makes the union between the two tissues even more frail than it was in the living tooth, and the breakage point more pronounced. Structural faults in the enamel itself form another element of danger. Owing to the method of calcification of the enamel caps in bicuspids and molars, certain defects or variations from the normal type are frequently met with. These defects are most common in the sulci of the teeth named. Calcification commences on the prominences of the cusps, giving rise to as many points of calcification as there are cusps. When they meet these cusps do not always unite, and a crack or crevice is formed. These faults are generally on the cervical portion of the enamel midway between the buccal and palatal faces. They differ from those found on other portions of the tooth, in that they resemble more closely an ordinary crack produced in sound enamel by mechanical force or desiccation.

"A third point in the form of the free margin of the enamel at the cervical border deserves attention. On the labial and buccal braces it is rounded, while on the approximal face it follows the line of the gingivæ, which curves sharply upward in this location. Teeth, especially the bicuspids, are constricted meso-distally on the median line, which, with the upward deflection of the enamel border, forms a cavity that cannot be reached by either tooth-brush or floss silk. When the gums from any cause become pressed down, a greater surface of the cementum is exposed to the action of the solvent acids that produce decay."

GENERAL PATHOLOGY.

By E. O. SHAKESPEARE, M.D.,

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Of the various and complex problems which "the pathology of the future" will doubtless finally solve, certainly not the least important will be those of the active causes and the practical means of prevention of specific, infectious and contagious diseases.

Through the labors of the bacterio-pathologists during the last half decade,—aided by the greatly perfected instruments of precision, exact methods of research and thorough training,—that which has been called "the germ theory of disease," has rapidly approached a positive demonstration. The general pathological consideration of the several diseases having been considered in the body of this work, this treatise will be devoted to the consideration of subjects attracting at the present time the special attention of the bacterio-pathologist.

ASIATIC CHOLERA.

During the last visitation of Egypt and Europe by Asiatic cholera, the etiology and diagnosis of the disease were made the subjects of governmental investigation. Hence from the standpoint of pathology, the various publications relative to certain micro-organisms claimed to be the cause of the disease are of so much interest that the editor takes the liberty of briefly reviewing the subject.

In 1883 a French Commission was sent to Egypt to investigate the cholera then raging there. When the Commissioners had announced the discovery of a small, round, flat plate in the blood, which they believed to be peculiar to cholera and perhaps concerned in the cause of the disease, the German Commission, in Egypt at the same time, proclaimed the discovery in the intestinal contents of the "comma bacillus" as an associate and probable cause of Asiatic cholera,—claiming for it a distinctive character of growth in gelatine culture media, and upon potato,

which enables it to be distinguished from all other bacteria of a similar form. They also claimed for it diagnostic value, inasmuch as this bacillus is not found in health or in any other disease. This Commission further investigated the subject in India and reaffirmed their claims, although not succeeding in producing cholera artificially by inoculation of numerous domestic animals of various species. The French Commission then abandoned their claims concerning the body discovered by them in the blood of cholera patients.

When the cholera appeared at Toulon and Marseilles, in 1884, numerous competent observers congregated there from many parts of Europe, chiefly intent upon testing the claims made by the German Commission for the comma bacillus. The chief of this Commission, Dr. Robert Koch, demonstrated satisfactorily to all present—including the members of the original French Commission—the existence of his bacillus within the intestinal contents of cholera subjects.

Nicati and Rietsch, of Marseilles, with pure cultures of the comma bacilli, undertook to produce cholera in some domestic animals, including the dog, rat and rabbit. They introduced this material directly into the small intestine by means of a Pravaz syringe, after opening the abdomen and ligating the bile-duct. They succeeded in producing symptoms similar to cholera and the death of the animal, and subsequently found that the same effects could be produced with ligation of the bile-duct. The experiments of Nicati and Rietsch were performed by E. Van Ermengun, Commissioner of the Belgian Government to investigate the cholera in the south of France. He confirmed the claims of Koch, as well as those of Nicati and Reitsch.

Koch conceived another method of introducing the cultures of comma bacilli into the small intestine without subjecting them to the destructive action of the gastric juices. He first neutralized the acidity of these juices by a previous injection through the mouth and œsophagus of bicarbonate of sodium, and a subsequent injection into the peritoneal cavity of a certain amount of tincture of opium. Symptoms similar to those obtained by Nicati and Reitsch and Van Ermengun, and to those of cholera, were thus obtained by Koch. Watson Cheyne, of London, repeated these experiments with confirmatory results, and numerous investigators

in France, Germany, Austria, Switzerland, Italy, Spain, etc., have been equally successful.

Meanwhile contradictory observations were by no means few. The late Dr. Lewis, of London, pointed out the existence in the normal human mouth of curved bacilli, having a form closely resembling that of the comma bacillus of Koch, and affirmed its identity with it solely on morphological grounds. E. Klein, of London, was in accord with Lewis, and asserted that identical microbes are to be found in simple diarrhœa and other non-malignant intestinal troubles. Reports were numerous of discovery of curved bacilli identical with those of the Koch bacillus, based solely on morphology or cultures in other media than the one which Koch had pointed out as distinctive for it. It was said to exist not alone in cholera asiatica, but in many other pathological and normal conditions,—to exist as well in natural water and in the air. Finkler and Prior announced the discovery of a curved bacillus in cholera morbus, having a form similar to that of the Koch bacillus, and they affirmed the identity of the two. Deneke discovered a curved bacillus in decomposing cheese similar in form to the cholera comma bacillus, but distinctly affirmed its non-identity, since its biological characters as observed in culture distinguished it. Miller, of Berlin, found two curved bacilli in the mouth, but acknowledged their biological difference from those of Koch.

The British Government appointed a Commission to proceed to India and investigate the observations and claims published by the German Commission. They reported adversely in general and in detail upon the claimed discoveries of Koch and his associates, stating among other things that the comma bacillus did not differ in its character and effects from many other bacteria of decomposition. Their conclusions were based mainly upon morphological characters. None of the few culture experiments undertaken by them were made with the culture media stated in all of Koch's announcements to be requisite for the distinction of the comma bacillus from other similar forms of curved bacilli. During the presence of cholera in Naples, in 1884, von Emmerich, of Munich, found a short, thick bacillus, rounded at the extremities, in the organs and blood of several cholera subjects. After experiments with it upon animals and cultures in Munich, he announced this

bacillus to be the cause of Asiatic cholera. His error was pointed out by Flügge, and by von Seelen, one of Emmerich's assistants in his original researches on this subject. The observations and conclusions have been contradicted by every observer who has gone experimentally over the ground of his work. Even Emmerich and Buchner, after their investigations upon the cholera at Palermo the next year, retracted most of the essential statements previously advanced by Emmerich. Roy, Brown and Sherrington, of Cambridge, visited Spain, in 1885, to study there the etiology of cholera. They agreed with Klein as to the diagnostic and etiological value of the comma bacillus of Koch. They also announced the discovery of another micro-organism as peculiar to and perhaps the cause of cholera. But the next year Sherrington, after his investigation of cholera in the southeast of Italy, distinctly abandoned their claim, not having succeeded in finding this peculiar micro-organism in the cholera subjects examined there.

Dr. J. Ferran, of Tortosa, in Spain, was commissioned by the Municipality of Barcelona to proceed to Toulon to investigate cholera there in 1884. He accepted the claims of Koch as a result of his observations. After returning to Spain, satisfied that not only was the comma bacillus diagnostic of cholera asiatica, but was also the specific cause of the disease, and accepting the doctrine of Pasteur and his school, that many of the infectious diseases could be prevented by anti-vaccination, he sought by experiment on animals to find a "vaccine" against Asiatic cholera. He announced toward the end of 1884 that by inoculating guinea-pigs with pure cultures of the comma bacillus, in doses less than fatal, he could protect them against the effects of subsequent doses twice as large as those certain to kill the unprotected animal; and he further stated that the same effect could be produced in the human being. The truth of this report was investigated by the Medical Society of Barcelona, many of its members subjecting themselves to the "vaccination." The Society endorsed the report. At the same time, Ferran had addressed a note of his claimed discovery to the French Academy, placing it in competition for the Biraut prize of twenty thousand dollars. In this note his method of procedure was set forth in detail. When cholera broke out in Spain, in 1885, Ferran began his human anti-cholera vaccinations, which were popularly believed to be successful. The right to continue these

inoculations became a matter of State consideration. The claims of Ferran were championed by the leader of the opposition in the Cortes in a bitter attack upon the policy of the Government in the enforcement of local land quarantine and sanitary cordons. From that movement in Spain the question of the truth or falsity of Ferran's claims became the subject of bitter partisan political dispute, in which there was but small chance for the real truth to be heard.

The Government several times prohibited the "preventive vaccination," and each time the demands of the populace caused the Government to recede. Meantime official commissions were appointed by the Government at Madrid to thoroughly investigate the results of the vaccinations, as also by numerous provincial governments. At the same time official records of the results of the vaccinations were directed to be kept by the proper officers in each town and province. The French Government sent a commission to investigate the results of these vaccinations; so also did the Belgian. Both of these Commissions got into personal disputes over the method followed by Ferran, and departed from Spain, having refused to investigate the practical results of the inoculations without first being placed in possession of the method by which they were obtained. The reports of these two Commissions were strongly adverse to the claims of Ferran. The official statistics of the anti-cholera inoculations, which were practiced on a large scale, have been collected and published since the visit of these two Commissions. The French Commission objected to the few statistics which they obtained, and which were favorable to the claims of Ferran, that among other faults they were not authentic, but represented the opinions of the friends of Ferran. The official statistics, as far as they go, are in strong support of the claim that the human being can be protected against attack and death from cholera by preventive inoculation. Whatever strength there is in mere numbers, they are lacking in sufficient detail as to the condition in life of those experimented upon. Whatever the faults of these statistics may be, however, they cannot fairly be charged with a partisan bias toward Ferran; for in the main they consist of records collected by officers in harmony with the Government, who were not friends of Ferran.

The question of immunity is brought up by the statistics

of Ferran. Is there an immunity, individual and local, conferred by an attack of cholera? Superseded and somewhat ignored as this important question has been, yet it has always attracted the attention of the most distinguished and experienced observers who have had to do with cholera in Europe.

If immunity exists, is there a means of artificially acquiring it by preventive inoculation of a living, or ptomaines produced by the living, agent of that virus? This is the question which Ferran attempted to settle in a practical manner. He found that the dead cultures of the comma bacilli are capable equally with the living, of conferring immunity in guinea-pigs, and he is supported in this by the last publication of D. D. Cunningham, of Calcutta. Ferran went still a step in advance, and extracted from the cultures of comma bacilli an alkaloid which, injected into guinea-pigs, protects them from the effect of fatal doses of either the living or the sterilized cultures of the comma bacilli. That the latter, if they be the cause of cholera, must produce their effect upon the general system through the agency of a poison,—a specific ptomaine absorbed into the blood,—is generally admitted. That there is a specific poison formed in the intestinal contents of cholera subjects, seems pretty clearly indicated by the experiments of Pouchet, Villiers, Nicati and Reitsch, Klebs, Richards and others. That the cholera bacilli cultures produce a peculiar chemical substance, is also pretty clear. The existence of such a substance has been attempted to be made of practical use as a ready means of diagnosis.

Cholera-Red.—As a result of a long series of experiments, C. H. Ali-Cohen[24] arrives at the following conclusions: (1) The so-called cholera reaction appears only with the use of impure mineral acids (containing HNO_2). (2) The so-called cholera-red is not a specific product of Koch's comma bacillus. (3) Koch's bacilli produce the indol derivative somewhat more quickly than do forms which are morphologically related. There is, moreover, one form (probably several), not morphologically related to the Koch bacillus, which is capable of producing the indol derivative quite as rapidly as the Koch bacillus. (4) With the latter, the color reaction has no diagnostic. This reaction may ultimately prove to be useful by means of a modified method. (5) The reaction applied to diarrhœal discharges has no value in respect

to the chemical nature of the coloring principle. (6) Bujwid's advice, to combine the reaction with plate-culture investigations, without awaiting the characteristic growth, is to be reprobated. (7) Only the already-worked-out methods of differential diagnosis by bacteriology should be followed.

Salkowski[7] shows [in opposition to Ali-Cohen] that for the development of the cholera reaction, absolutely pure sulphuric or hydrochloric acid is necessary. The use of nitric acid and of reagents containing nitrous acid is absolutely to be avoided, because solutions of indol yield with nitrous acid, or with sulphuric acid containing nitrous acid, a purple or violet color. Such acids are therefore worthless for the demonstration of the presence of the cholera bacteria.

Nevertheless, the author finds that the cholera reaction is nothing else than a quite common indol reaction. Consequently the explanation of the fact that this indol reaction occurs in cholera cultures, even with (pure) sulphuric acid, lies simply in the fact that the comma bacilli constantly produce nitrous acid, which is found in the fluid in the form of nitrites. Therefore there is no specific cholera-red, as Brieger has believed. This substance is rather a simple indol red, and is demonstrable in any decomposing peptone solution. The comma-bacilli are characterized only by the simultaneous production of indol and nitrous acid.

In every cholera culture the author was able to demonstrate not only the presence of previously-formed indol (in the destillate), but also nitrites were found (in the residue after distillation). A fluid containing these two bodies must consequently yield the indol reaction by the addition of perfectly pure sulphuric acid. Hence one can obtain the cholera reaction also with the residue of the distillation of cholera cultures if to this residue one adds either an equal volume of this destillate (which in fact contains the indol) or of a destillate from a similarly treated decomposed peptone culture, or finally of an indol solution of .06–.1 per 1000. The decomposed peptone culture also yields indol by distillation; but the residue contains no nitrous acid, and therefore gives no (cholera) reaction with sulphuric acid.

The question is now raised whether the cholera reaction loses its diagnostic value, since it is based upon the indol reaction. Its value will become lessened without doubt since it no longer has

to do with a specific product of the cholera spirilli, but with a combination of two products of decomposition. We should in every case aim to use a pure cholera culture for the inoculation of the peptone solution. Otherwise the negative absence of the reaction in no way proves the absence of cholera bacteria, and even a positive result is not fully conclusive; for both indol and nitrous acid can be found in the culture of different bacteria.

According to Jadassohn's[1] investigations, hydrobromic acid, phosphoric acid, and tartaric acid, as well as lactic and oxalic acid, give the reaction. Hydrochloric acid, for the following reasons, holds the front rank: (1) It does not change the color of the commonly used culture media, whilst nitric acid gives the yellow coloration which is known under the name of xantho-protein reaction. Sulphuric acid frequently colors the culture media strongly brown, and can thereby conceal the development of the cholera-red. (2) The hydrochloric acid has, as will be pointed out later, the greatest, perhaps the only really practical, value as a means of differential diagnosis. On the contrary, nitric acid gives the earliest complete reaction; sulphuric acid the quickest and most energetic. The author studied the conditions under which the cholera reaction makes its appearance, and began with the culture medium.

(*A*) *Culture Medium.*—Sterilized reservoir water furnishes a not inconsiderable growth of the comma bacillus. Nevertheless such cultures give no cholera-red reaction. In a medium similar to the Pasteur solution, the bacilli develop a little more abundantly than in water, but furnish no cholera-red. A considerable growth in pure water and gelatine is to be observed, but no reaction follows. The same is the case with sugar and starch solutions, and with meal pap. Slight reaction appears, but only after some days, in simple veal-broth: yet a very small quantity of albumin could be demonstrated in it. Chicken albumin (the part which remains in solution after boiling with water), the fluid of hydrocele and blood serum, gave a good reaction only after some days. In sterilized milk the bacilli grew well, but gave no reaction.

The culture media generally used in the laboratories gave very good and prompt reactions. In flesh peptone-agar, after six to eight hours, at the temperature of the incubator, not only was the

portion immediately around the culture colored, but the whole of the agar contained in the tube became red. Flesh peptone-fukus and flesh peptone-gelatine media behaved in a similar manner. If, as Dunham says, a brown instead of a red color appears in these cultures, this depends, according to Jadassohn, upon carbonization of the culture material by means of sulphuric acid. Hydrochloric or dilute sulphuric acid therefore should be employed. Good results are likewise to be obtained by use of the solutions of Dunham. (Natrium carbonate, salt ½ per cent., peptone 1 per cent.) From the foregoing, it appears that in culture media free of albumin, the cholera-red does not form. In media which contain non-peptonized albumin (except milk) the reaction appears late and weak. The author rightly believes in the possibility that the albumin becomes peptonized before it is broken up by the comma bacillus. [This was proven experimentally by H. Bitter in 1886.]

(*B*) *Action of Oxygen.*—Although the cholera spirillium needs for its development only a little oxygen, the cholera-red does not form at all in the absence of oxygen. In order to obtain an abundant production of the same, the added oxydizing agent must therefore be relatively considerable. Cultures which are covered from the air by means of a layer of oil, give, even after weeks of growth, no cholera-red reaction, although the cultures have grown abundantly. After drawing off the layer of oil a distinct reaction subsequently appears.

(*C*) *Purity of the Culture.*—Bujwid says: "If the culture is not pure, that is, if it contains many other bacilli, the reaction does not succeed." Dunham inoculated culture media with a mixture of human fæces and cholera bacilli. After five hours the reaction with sulphuric acid made its appearance; but after twenty-four hours it no longer occurred. The author had similar experiences with the intestinal contents of a guinea-pig, which had been inoculated with Koch's comma bacilli. Furthermore, culture media were simultaneously inoculated with cholera bacilli and with others which give no reaction. At about the same stage of development both showed during the first days only a very slight or no reaction with hydrochloric acid, a weak reaction with sulphuric acid, and always a strong reaction with nitric acid. Very interesting were the following experiments: Cultures were sterilized. They gave a

very good reaction with each of these acids. Then they were inoculated with other bacilli which of themselves give no reaction. After three days only the nitric acid was effective: the other acids produced no reaction. This behavior shows that the nitric acid reaction is based upon other conditions than those required for the other two acids; and it is not impossible that different substances may be colored red by the different acids.

The author tested a large number of bacilli for the cholera reaction without result.[25] Five species of bacilli behaved very similarly with respect to the acid reaction: these were the Finkler-Prior, the Deneke, and the Miller spirillium, and the Passet (bacillus pyogenes fœtidus) and the Emmerich (Naples) bacillus. These, in peptone solution, kept in the incubator, often gave with the nitric acid a violet reaction even after 18–20 hours. Hydrochloric acid gave only after some days a slight red color, or none at all. Sulphuric acid often failed entirely, or was markedly behind the nitric acid in its action. Old cultures of these bacilli behaved like impure cholera cultures. The "chromogen" of these bacilli, as well as the red coloring material produced by nitric acid, disappear (lösen sich) in the Brieger media: only with nitric acid do they show the color in these solutions; with the other acids scarcely or not at all. Decoloration takes place upon addition of alkalies, and the red appears only after the addition of acids.

Jadassohn discusses also the analogy between "pyocyani" and cholera-red, and some other colors which are produced by the action of the micro-organisms.

The following are the conclusions of the author:—

(1) Pure cultures of the cholera bacilli in culture media containing peptone give with hydrochloric acid a red color after a short time, which up to the present is found in no other species of bacilli. (2) The same coloration appears after addition of nitric and sulphuric acid; but this reaction is less characteristic, because especially the nitric acid reaction appears after a somewhat longer time of development; also in cultures of the spirillium of Finkler, Prior, Deneke, Miller, and of the Naples bacillus, and bacillus pyogenes fœtidus. (3) The cause of the cholera-red reaction is the existence of a substance—according to Brieger's investigations, an indol derivative—which is formed in peptone or albumin cultures, and only in the presence of a considerable amount of oxygen.

(4) Impure cultures of comma spirilli mostly give only the nitric acid reaction.

From the foregoing Zäslein[25] understood that Jadassohn was of the opinion that the nitric acid reaction is due to other conditions than those which give rise to the reaction of hydrochloric acid or sulphuric acid. The following examples from a series of experiments upon this point may probably contribute to an explanation of these conditions: (1) A six-day old culture in peptone gelatine of the Deneke spirillium gives with hydrochloric acid no reaction; six drops of nitric acid (six weeks before, chemically pure, even now free of water, but is observed to fume), gives a brownish-red reaction. A trace of nitric acid, containing nitrous acid (yellow and distinctly fuming), yields a red reaction. When these solutions are neutralized, a color material goes over with the ether, etc., in the process of distillation. (2) Impure cholera cultures give with six drops of sulphuric acid a yellow reaction; with hydrochloric acid no reaction; with six drops of nitric acid, a brownish-red reaction; with a trace of nitric and nitrous acid, a beautiful red reaction. This culture, distilled with acetic acid, gives a colorless destillate which colors with hydrochloric acid not at all; with sulphuric acid, a scarcely visible reddish yellow; with six drops of nitric acid, a slight red yellow; with a trace of nitric and nitrous acids, an intense and very beautiful red-violet. (3) Pure cholera cultures (24 hours old) become with hydrochloric acid, violet-red; with six drops nitric and nitrous acids, are orange, then decolors; with a trace of nitric and nitrous acids, a violet-red; with six drops of nitric acid, a violet-red.

It seems to be shown by these experiments that cultures of the Deneke spirillium and impure cholera cultures, which give a reddish-brown reaction with nitric acid, and none at all with hydrochloric acid, as well as the pure cholera cultures which give the violet reaction with hydrochloric acid, all yield a distinct red or red-violet color with a trace of nitric and nitrous acids. Now, since the reaction with a trace of nitrous acid appears constantly in greatly diluted cultures, the editor may raise the question whether the so-called nitric acid reaction, at least in all except the cholera cultures, has to do in reality with the presence of a trace of nitrous acid and not with nitric acid; in favor of this is the circumstance that the reaction is always more distinct and intense with

the trace of nitrous acid (except in pure cholera cultures) than with six drops of nitric acid. Nitric acid should therefore be entirely eschewed, as also sulphuric acid, which not infrequently contains nitrous acid as an impurity.

As to the etiological claim which Koch made for his comma bacillus, results of investigations and opinions based thereon have much differed; and the matter may be said to be still at issue, with the weight of evidence preponderating on the side of Koch. As to his claim that the comma bacillus is diagnostic of Asiatic cholera, nearly all, including most of those who originally opposed it, admit that it has been fully established by most overwhelming proof.

As United States Cholera Commissioner, the editor has been among the last to go fully over the disputed ground. From his observations and experiments in Europe, India and America, he regards the comma bacillus of Koch as absolutely diagnostic of Asiatic cholera. As to the matter of etiology, he accepts it as highly probable that the comma bacillus of Koch is the specific cause of the disease.

The first occasion of practical application of the diagnostic value of the comma bacillus for the benefit of a nation was at the appearance of suspicious cases at Mayence, when Gaffky, of the German Commission, decided the disease to be cholera asiatica. The second occasion was on the appearance at New York of the second French steamer from Marseilles and Naples with suspicious but undeclared cases aboard. The suspicions were confirmed by Dr. Biggs by discovery of the comma bacillus in the stools.

E. Klein,[26] who was chief of the British Commission sent out to India, in 1884–85, by his Government to investigate and report upon the observations and claims previously made by the German Commission relative to the diagnostic and etiological value of the comma bacillus of cholera, and who made an adverse report as to both claims of the German Commission,—that is, denied both the diagnostic significance of the comma bacillus of Koch, and its etiological value,—now, after further investigation, admits: "One thing, however, may be said with certainty, namely, that as far as our limited knowledge at present goes, in no intestinal disorder in man have comma bacilli, behaving in artificial cultures like those

of Asiatic cholera, been yet found in the intestinal evacuations. . . . Hence I agree to the proposition that if in any case of diarrhœa the choleraic comma bacilli can be shown both by the microscope and by culture experiments to exist, then the suspicion that it may be a case of Asiatic cholera is quite justified. And it must be clear from this that the discovery by Koch of the choleraic comma bacilli is, on practical diagnostic grounds, of the utmost importance."

Klein has, however, made no modification of his denial that the comma bacillus of Koch has been shown to be the specific cause of Asiatic cholera.

Apparently the author has also modified his views concerning the infectiousness of cholera since the presentation of his official report, in which he clearly seemed inclined to adopt the opinion of a few high sanitary officers in India, who hold that cholera is no more infectious or transmissible from place to place than is malaria; for, upon that subject, he now speaks as follows: "It must not, however, be supposed that I mean to question the statements that cholera dejecta have produced infection, or that water contaminated with cholera dejecta has produced cholera. Such cases of infection are well established. Snow has minutely described one such epidemic,—the noted Broad Street Pump Epidemic,—and this is only one among many noticed in former and recent epidemics in Europe. As soon as a certain impure water supply was stopped, cholera cases ceased. To such a water supply—a river or a well—cholera dejecta had probably had access. This question of the importance of drinking water as a vehicle of contagion may, I think, be considered settled."

After discussing the so-called "Naples bacillus" of von Emmerich as the cause of cholera, the author declares that he "quite agrees with those who say that of the two (Koch's or von Emmerich's) Koch's comma bacillus has undoubtedly a stronger claim than von Emmerich's."

During a suspected outbreak of cholera in Krain, the intestinal contents were sent to Gruber[23] to ascertain the presence or absence of cholera bacilli. The material reached him four or five days after death in a highly putrid state, the weather being very warm. It was therefore probable that by that time the cholera bacilli were mostly dead, and Gruber had to find methods

which would yield positive results. In twenty-two specimens sent to him he found the cholera bacilli by direct plate cultures only in eight cases. He therefore from the first employed the method recommended by Schotellius,—adding a small quantity of the material to a vessel containing sterilized meat infusion, and placing this at 36° C. for 24 hours.

According to Schotellius, the cholera bacteria grow rapidly and form a layer at the surface. But Gruber did not find this plan satisfactory, and accordingly tried the method suggested by Buchner, by which one cultivates cholera bacilli for 7 days at 37° C. in a meat infusion containing 1 per cent. of peptone. This broth is then boiled and diluted with ten times its volume of .6 per cent. solution of common salt. A small quantity of the material supposed to contain cholera bacilli is then sown in this diluted infusion. The idea is that in this fluid a considerable amount of the products of the cholera bacilli are present, and are more inimical to the growth of other bacteria than to that of cholera bacilli. Hence if the latter are present in the material under examination, even in small numbers, they will rapidly develop and form a thin layer at the surface.

Gruber obtained better results with this method than with that of Schotellius; but he made a very important observation in connection with it. He found that when old material was added to this fluid the cholera bacilli in several instances did not appear till after the lapse of a number of days (in one case of 15 days).

This is of great importance, not only for the technique, but also for the agency of the bacilli in producing cholera; for Gruber considers that Pettenkofer is correct in so far as he says that the cholera organisms must spread in the soil and that the epidemic only breaks out after this has occurred.

It was first supposed that in the struggle for life with other bacteria, the cholera bacilli went to the wall; but the above observation shows that this is not always the case. Gruber is making further observations on the concurrent growth of these bacilli with other sapprophitic bacteria, more especially with those present in the soil. Though these investigations are not yet ended, they already show that the cholera bacilli hold their ground very well when grown along with those found in the soil, if only plenty of oxygen is present.

RABIES.

Ernst[14] relates a most extensive series of careful experiments, having begun them with strong conviction concerning the fallacy of Pasteur's claim for the inoculation of attenuated virus of rabies.

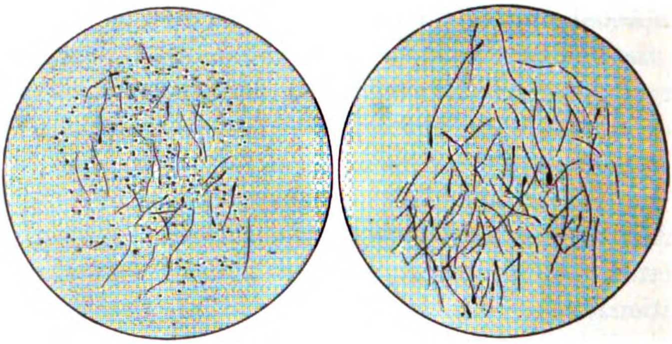
The conclusions which may be drawn from the work here recorded seem to be as follow: (1) "There exists in the cords and brains of animals inoculated in Pasteur's laboratory a specific virus capable of the production of similar symptoms through a long series of animals. (2) That these symptoms are produced with absolute certainty when the method of inoculation is by trephining the skull and injection under the dura-mater; with less certainty when the inoculation is by subcutaneous injection. (3) That the strength of this virus is lessened when the cords containing it are removed from the animals and placed in a dry atmosphere at an even temperature. (4) That the symptoms produced by the inoculation of this virus only appear after a certain period of incubation; distinctly shorter when the inoculation has been done by trephining than when done by subcutaneous injection. (5) That injections of the virus modified in strength by drying and in the manner prescribed by Pasteur, exert a very marked protective influence against an inoculation with virus of full strength. (6) That a very moderate degree of heat destroys the power of the virus entirely, whilst prolonged freezing does not injure it. As will be seen, all of these conclusions are in complete accord with the declarations of Pasteur. Their importance lies in the fact that they were reached at a distance from him, and all work entirely separated from any personal influence or bias." In discussing this paper, the editor related his experiences[15] in the inoculation into rabbits and cats of rabic virus, obtained from Prof. V. Horsley, of the Brown Institution, London, who himself had obtained the virus directly from Pasteur. Mainly, his experiments were in accord with those reported by Dr. Ernst, and support the claim of Pasteur as to the existence of virus in the nervous system of rabic animals, the possibility of attenuating it, and the transmission of the disease from animal to animal with invariable results.

Early in 1885, during the outbreak of rabies in London, Dowdeswell began the first experiments made by subcutaneous inoculations with the saliva of rabid street dogs. All failed to

produce infection. Subsequently, after adopting the methods of Pasteur, the author found: (1) That the virus of rabies and of hydrophobia resides in the cerebro-spinal substance and in the peripheral nerves, and is not confined to the salivary glands, as hitherto supposed. (2) That by inoculating this substance upon the brain of another animal by trephining, infection follows much more quickly and certainly than by subcutaneous inoculation. (3) That rabies, however produced, in both dogs and rabbits, is essentially a paralytic affection,—the same disease in both animals; and that there is no constant distinction between the so-termed "dumb" and "furious" rabies. (4) That the initial virulence of street rabies is commonly increased, and becomes remarkably constant, by passing through a series of rabbits. (5) That the activity of the virus is shown by the duration of the incubation period, to which it is inversely proportionate. (6) That the tissues of an infected animal do not themselves become infective until toward the end of the incubation period. (7) That of a large number of drugs which were tried, both germicides and those acting specifically upon the cerebro-spinal system, none materially modify the action of the virus in the rabbit. (8) That by a series of subcutaneous inoculations with virus treated by the methods of M. Pasteur, immunity even against subsequent infection cannot be conferred upon the rabbit; and that the extreme and unexpected constitutional refractoriness of the dog to infection with rabies, by any method of inoculation,—as found in the limited number of experiments,—renders it extremely difficult to determine the effect of such remedial or prophylactic measures in it; and that it is by the statistics of the treatment alone that their effect with man can be decided; but that judging from the results of the experiments of others, the principle of the method as affirmed by M. Pasteur appears to be established, though unquestionably the "rapid" or "intensive" treatment is liable to produce infection.

Dowdeswell[3] found a micrococcus in the cerebro-spinal tissues in some cases of rabies, but has been unable to cultivate constantly. With it he inoculated one rabbit subcutaneously. The animal was unaffected for three months. It was then reinoculated intracranially with a portion of medulla of intensified virulence. Here, also it remained unaffected for upward of two months, when, being again inoculated, it died on the second day from accidental causes.

Motte and Protopopoff[20] inoculated a young wolf hypodermatically from the brain of a dog which had died of natural rabies of the furious type. This wolf died of paralytic rabies, and the virus from its brain was transmitted through several rabbits by trephining. The cerebro-spinal fluid of the rabbit of the sixth series contained an enormous number of extremely minute, short and very mobile bacilli of a very special kind. In fact, the fluid represented a natural "pure culture" of the micro-organism. Culture of these bacilli were made and these were injected into four animals by trephining or hypodermatically. In the former case all died of paralytic rabies in twelve hours; in the latter, from two to six days. [In view of the rapidity of death in these cases, it is extremely doubtful if these authors were really dealing with a microbe which causes rabies.—Ed.]



Figs. 1 and 2.—Bacilli in the Emulsion of the Medulla Oblongata of a Hydrophobic Rabbit.—(*Journal de Médecine de Bourdeaux.*)

Solles[21] found a bacillus in cultures of an emulsion of the medulla of a hydrophobic rabbit intended for inoculation; but he did not commit himself as to the pathogenic character of this microbe or of its causal relation to rabies. (See Figs. 1 and 2.)

Bardach[22] relates the case of a woman who was bitten by a rabid wolf. After the bite she ceased to suckle her infant. A small quantity of the milk was taken from the mother's breast and injected into the cranial membranes of dogs and guinea-pigs. All the animals injected were seized with typical madness. The mother died; but the child that was taken from the breast after the bite still lives and appears perfectly healthy.

A rabbit inoculated with rabies was obtained from Pasteur's

Laboratory by Perroncito and Carita. On December 17, 1886, a pregnant rabbit near the end of its pregnancy was inoculated from the cord by trephining. Four days later the animal was uneasy, and evidently about to be confined. On the following morning the head of a small fœtus was found in the cage, the body having apparently been eaten by its mother. In a few hours a second living rabbit was born, and afterwards two others, which were dead when found,—probably killed by the mother. The living animal also died soon after its birth. The mother died with rabbit hydrophobia on December 26th. With the cords of the two perfect fœtuses, two guinea-pigs were inoculated,—one from each cord. Of these, one died with all the symptoms of rabies on January 1, 1887; the other remained well. To be quite certain that the guinea-pig had died of rabies, two guinea-pigs and one rabbit were inoculated in the usual manner from this. Of these one guinea-pig died on the seventh day, and the other on the eighth day, with all the characteristic symptoms of rabies. The rabbit also became ill, as usual, on the seventh day, and died on the twenty-first day of true hydrophobia. Hence there is no doubt that, in the case of one fœtus, rabies had been transmitted from the mother to the fœtus in utero; but that, as in the case of anthrax, not all the fœtuses of the same litter were affected.

Vestea and Zagari[15] confirm Pasteur in most particulars. Among other subjects of experimentation they gave much attention to "transmission of rabies by the nerves." The authors claim that the results of direct inoculation into a nerve-trunk are as certain as of those made under the dura-mater; and furthermore, that the period of incubation, as well as the first symptoms, *vary according to the nerve inoculated.* The authors performed a very interesting series of experiments, from which they conclude that rabies is transmitted by the nerves; that the bite is equivalent to an intra- or peri-neural inoculation; and that the fact of the propagation of the virus along the nerves is the cause of the symptomatic differences in the commencement and in the ultimate course of the disease, according to the location of the bite.

Freudenberg[16] states that Pasteur himself admits that his preventive treatment, including also the new so-called "intensive method," does not afford an absolutely certain prophylaxis against the outbreak of hydrophobia in one who has been bitten. But

that should not be expected in the case of treatment by the most perfect method ever possible.

Even vaccination does not always prevent variola. Quinine against malarial fever, sodium salicylate and antipyrine against articular rheumatism, mercury against syphilis, sometimes fail. Yet the usefulness of these remedies is not to be doubted, nor their application to be abandoned. That the results to which the various experimenters attain still differ in many respects, is no longer to be wondered at by reason of the relative novelty of the subject and method.

Pasteur[6] is of opinion that, besides the rabic microbe in the spinal marrow, there exists a "vaccinal matter;" that the microbe retains its virulence during the drying, but loses its power much more rapidly than does the "vaccinal matter;" and that this "vaccinal substance," by successive inoculation, renders the nervous centres immune before the microbe succeeds in developing therein; whilst in the case of no successive inoculation the microbe acts earlier than the vaccinal matter. In this connection, Pasteur cites 35 dogs which were injected subcutaneously with a given quantity of rabic virus (street rabies or virulent virus): 18 of them died of rabies. The remaining 17 were subsequently inoculated intra-cranially with street rabies virus. Thereafter, only 5 died; 12 remained well.

Von Fritsch[17] concludes that much more work must be done before it is demonstrated that animals can be protected from rabies by inoculation; that no real ground exists for the belief in the efficacy of preventive inoculation in the human subject; while there is a strong probability that through inoculation of virus disease itself may be transmitted.

Gamaleia,[5] of Odessa, believes that the prophylaxis of rabies after the bite is not the theoretical impossibility it is supposed to be by many. As one can conceive that the vaccine virus, whose development reaches its highest point on the ninth day, inoculated soon after an infection with variola, still displays its protective action (for the incubation period of that disease is 12 days), so may be conceded the possibility of rendering the body also refractory against rabies, with its usually long period of incubation, before the infecting virus reaches its development.

Alfonso di Vestea,[18] of Naples, performed experiments in the

main harmonizing with the results of Pasteur, though, like Fritsch, he did not succeed in protecting rabbits which had previously received a subdural injection of the virus of street rabies.

The report of the committee appointed by the British Parliament in 1886 to investigate the Pasteur method was looked for with interest on all sides. The Secretary of the Commission, Victor Horsley, made a number of careful experiments, in which it was satisfactorily proved that a substance may be obtained from the spinal cord of an animal dead of hydrophobia which, if inoculated into another animal, will produce hydrophobia similar to that caused by the bite of a rabid animal, except that the period of incubation is altered.

The rabies thus transmitted by inoculation may by similar inoculations be transmitted through a succession of rabbits with marked increase of intensity. But the virus in the spinal cords of rabbits that have died of inoculated rabies may be gradually attenuated by drying the cords; so that, after a certain number of days drying, it may be injected into healthy rabbits or other animals without any danger of producing rabies. By using on each successive day the virus dried during a period shorter than that used on the previous day, an animal may be made almost certainly secure against rabies, whether from a bite or from any method of subcutaneous inoculation.

This protection is proved by the fact that if animals so inoculated and others not so inoculated be bitten by the same rabid animal, none of the first set will die of rabies; while with rare exceptions those of the second set will succumb.

The committee therefore hold that it may be deemed certain that M. Pasteur has discovered a method of protection from rabies comparable with that which vaccination affords against small-pox. They think it certain that the inoculations practiced by M. Pasteur have prevented the occurrence of hydrophobia in a very large proportion of those who, if they had not been so inoculated, would have died of that disease.

They are not sure that the intensive method of inoculation is free from danger, but rather incline to think that deaths may have been due to it; for, as has been previously pointed out, a form of rabies, the paralytic, not met with in the rabies of the street, has supervened on inoculation by the intensive method. M. Pasteur

has, however, greatly modified this plan of treatment, and employs it only in the most urgent cases.

As far as the report applies to animals it seems conclusive; and both directly and inferentially the testimony is very strong as regards human beings. There remains, however, the objection, urged some time since by Peter and Colin, that the census returns show about as many deaths in France from hydrophobia since the beginning of the practice of inoculation as before, notwithstanding the large number of cures claimed by Pasteur.

Once stripped of every difficulty, and thoroughly established, it would be impossible to overestimate the importance of the discovery, both as regards its practical utility and its importance in general pathology. It shows the possibility of an unlimited application of a method, the like of which it may become possible to employ for the protection of both men and animals against others of the most intense kinds of virus. In the not very distant future, in some form of inoculation, an effective preventive may be discovered for every kind of infectious disease. Then vast regions of the earth, now dominated by constant apprehensions of invasion by scourges, will offer opportunities of life as little troubled by them as civilized lands now are by apprehensions of small-pox.[27]

Biological Effects of Essence of Tansy, and Preventive Action of Hydrate of Chloral against Tanacetic and True Rabies.—Peyrand states that the essence extracted from the *Tanacetum vulgare* (vermifuge) produces convulsions which absolutely differ from those of essence of absinthe; for they have a tetanic and not an epileptic type, and are not prevented by the previous administration of the bromide of potassium. The type of these convulsions is really rabic; for there is hallucination, loss of consciousness, convulsions, spasm of the muscle of the pharynx, larynx, and of the whole thorax, abundant salivation, phenomena of asphyxia, tending to bite, characteristic hoarse cry, temporary (momentannée) paralysis. In some cases there was manifest exacerbation of the convulsions by the presentation of a mirror. Therefore the author is induced to give to the tanacetic convulsions the name of tanacetic rabies, artificial rabies, simili-rabies. The previous action of chloral, which has no curative action upon the tanacetic rabies, has the effect of preventing the tanacetic convulsions.

SCARLET FEVER.

Dr. Klein, in his recently published report on the results of his investigations on the Hendon cow disease and its connection with human scarlatina (alluded to in the department of *Diseases of Childhood*), fails to state in how many cases of human scarlatina he found the organism, in what stage of the disease, or where. There are apparently no experiments on calves with scarlatinal blood to show that blood had the same effect on the animals as the organisms cultivated, and that that effect was the production of the Hendon disease, and no control experiments with the pyogenic and erysipelatous streptococci, which Dr. Klein's organism very closely resembles. In fact, there seems to have been an entire absence of proper controlling experiments. In one respect Dr. Edington supplies an omission, though incompletely, namely: he injected blood from a scarlatinal patient into a guinea-pig, whence he obtained a similar result to that got on the injection of his bacilli. Had the injection been made into a calf, we should have seen whether the Hendon disease resulted. Another point adverse to Dr. Klein's view is that the Hendon disease is apparently a moist eruption, not the dry eruption of scarlet fever. Dr. Edington produced a dry eruption, followed by a desquamation (not by peeling off of crusts, as in the Hendon disease), by injection of scarlatinal blood into guinea-pigs, and of his bacilli into a calf.

Several researches made in Germany—notably Loeffler's on diphtheria—have shown the presence of streptococci in the blood-organs of patients who have died of scarlet fever, and have also shown that there were cases of mixed infection,—a condition not to be wondered at when the state of the throat, allowing the entrance of the bacteria into the blood, is borne in mind. It will not be surprising if the streptococci described by Dr. Klein turn out to be derived from this source, and not to have any real bearing on the causation of scarlet fever. It is clear that we must not be hasty in arriving at a conclusion on this subject, but must consider the matter still open, and await further researches.

The Agricultural Department of the Privy Council office has been making some investigations on the subject at the instance of the Royal Agricultural Society of England. If there is any meaning in a report by Professors Axe and Brown which has just

been officially published, the Agricultural Department disbelieves altogether the conclusions at which Mr. Power and Dr. Klein arrived. The medical as well as the agricultural world is deeply interested in having the question raised by Dr. Klein settled. Diseases of which veterinarians have as yet taken no sufficient account may have a serious influence upon the milk yielded by cows, and thus upon the constitutions of the human beings drinking it.

It is admitted that scarlet fever in its early stages is little if at all communicable from the sick to the sound. On this first principle rests the advantage of prompt isolation, since a fair chance is thereby afforded of arresting the farther extension of the disease from its primary source. It is also admitted that the flakes of skin cast off during desquamation contain the active contagium; and these, if inhaled or swallowed, reproduce scarlet fever in those unprotected by not having already passed through the ailment.

Dr. Jamieson[2] endeavors to prove that, without separation, it is possible to prevent communication of scarlet fever from one member of a family to others of the same who had not had it, even though in close contact or occupying continuously the same apartment. He states that the two sources of infection are the exhalations from the mouth and throat in the early stage, and the dry particles of cuticle cast off later. The method recommended is to disinfect the throat by painting it frequently with a strong solution of boracic acid in glycerine (a saturated solution of boroglyceride). In dealing with the skin more exact methods are available. These consist in the employment of warm baths every night from the onset, and application to the entire surface of the body, including the head, of an ointment composed of carbolic acid gr. 30, thymol gr. 10, vaseline ℥j, simple ointment ℥j, night and morning. In this way he believes that the scales of epidermis will never become contagious. His experience bears out this opinion.

Dr. Jamieson[3] made investigations with a view (1) to discover the organism in the desquamation, to the presence of which the contagious properties of the cast-off flakes are inferred to be due; (2) to ascertain the period at which the organism first manifests itself in the desquamating epidermis; (3) to ascertain if the methods which have been found capable of neutralizing the contagiousness of scarlet fever are sufficient to destroy this organism,

or to render it incapable of reproduction, though under suitable conditions otherwise.

Cultivation and inoculation experiments from the blood and desquamating cuticle were carried out by Dr. Edington.[2]

The following is a list of the various organisms isolated, and is taken to apply to cultivations made in jelly that has been neutralized in caustic potash, unless otherwise stated. It had been found that cultivations made in such jelly differed in some cases from that made in soda jelly, and this has been of considerable use as a means of distinguishing various organisms. The form of growth does not materially alter; but in potash jelly it is in almost all cases more luxuriant and more rapid, and in some cases a peculiar and individual darkening of the deep needle-track growth results after a time:—

(1) *Sarcina Lutea.*—This well-known organism occurred in 15 per cent. of the original cultures from desquamation.

(2) *Streptococcus Rubiginosis* (provisional name).—It occurred in 20 per cent. of the original tubes. Inoculations into rabbits, guinea-pigs and pigs gave negative results.

(3) *Micrococcus Capsaformans* (provisional name).—Spherical or oval bodies, frequently united as dumb-bells, which are very often enclosed with a capsule. (See Fig. 8, and some also may be seen in Fig. 11.) This capsule is well seen on staining with alkaline methylene-blue. It occurred in 40 per cent. of the original tubes. Inoculations gave negative results in rabbits, guinea-pigs and pigs. (See Fig. 8.)

(4) *Diplococcus Scarlatinæ Sanguinis* (provisional name).—Spheres measuring 1.0 m. to 1.2 m., frequently, especially in fluid cultures, existing as dumb-bells. On gelatinous plates it forms creamy points of fairly rapid growth. On test-tubes of Koch's jelly it forms a deep growth of very closely-pressed minute cocoons, while the surface growth, usually irregularly heaped up around the needle-track, is of a slightly creamy-white translucent color. It occurred in 45 per cent. of the tubes taken from the desquamation, and in 30 per cent. of the tubes made from the scarlatinal blood. Inoculations gave negative results. This will be referred to when speaking of the bacillus scarlatinæ.

Ascobacillus (provisional name).—Small rods in their fully developed form, measuring 0.8 m. in length, and 0.2 m. in breadth,

often as dumb-bells, made up of long, ovoid spheres. This organism is peculiar in that the spores are contained in large, sausage-shaped capsules many hundred times larger than the bacilli themselves. (See Fig. 7.) This was obtained only in one case, with the bacillus scarlatinæ, in which death resulted in twenty-four hours, and was obtained from the blood.

Bacillus Fulvus (provisional name).—Very small, oval or rod-shaped motile bodies, measuring 1.0 m. to 1.5 m. in length, and 0.2 m. in breadth. (See Fig. 4.)

Bacillus Arborescens (provisional name).—Rods measuring .8 m. in thickness and 4 5 m. to 12.0 in length, most usually the former. This organism usually forms excessively long-jointed leptothrix filaments, either in jelly or in fluid media. It is non-motile. (See Fig. 9.) Inoculation into rabbits and pigs gave negative results. In guinea-pigs a well-marked local erythema developed, but did not spread far from the point of inoculation, and was unattended by any sequelæ.

Bacillus Scarlatinæ (provisional name).—Rods measuring 0.4 m. in thickness and 1.2 m. to 1.4 m. in length, most usually forming excessively long-jointed and curved leptothrix filaments, motile. (Fig. 10.) Sown on gelatine plates, it forms little points of liquefaction after several days. Sown in the test-tubes of Koch's jelly, it rapidly liquefies it, but with no distinct growth-formation. The fluid thus formed is crowded with the motile bacilli; but a pellicle is not formed until the liquefaction is well advanced.

It occurred in every case but one of the tubes made from the desquamation, if taken after the termination of the third week, but never before this. It also occurred in every tube made from scarlatinal blood, if taken before the third day of the fever. Inoculation made into rabbits was always attended with a slight but marked erythema if they were young; but if old, the erythema was better developed and most vivid at the point of inoculation. After two to five days a fine desquamation began, and usually lasted for a week to ten days. The temperature usually rose slightly in the younger rabbits, but more in the older; for example, 103° to 104° and in one case 106° F. During the first two days the animals huddled themselves together in a corner of the cage and did not seem much to wish food, but usually after this day got quite lively again. The bacillus can be reobtained from the

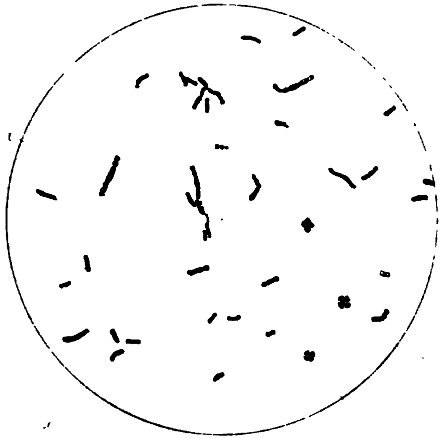


Fig. 1
Original impure cultures from skin
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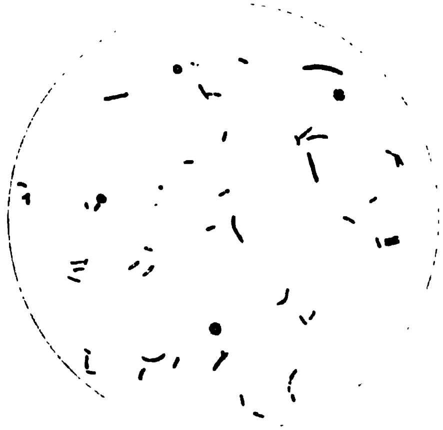
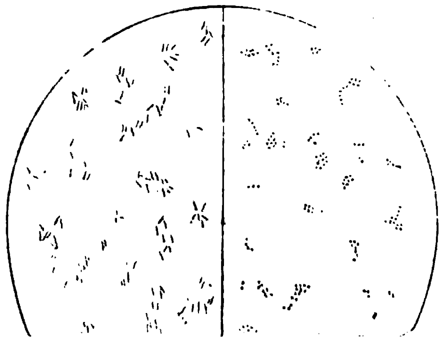
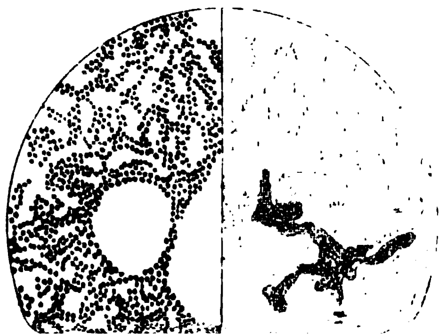
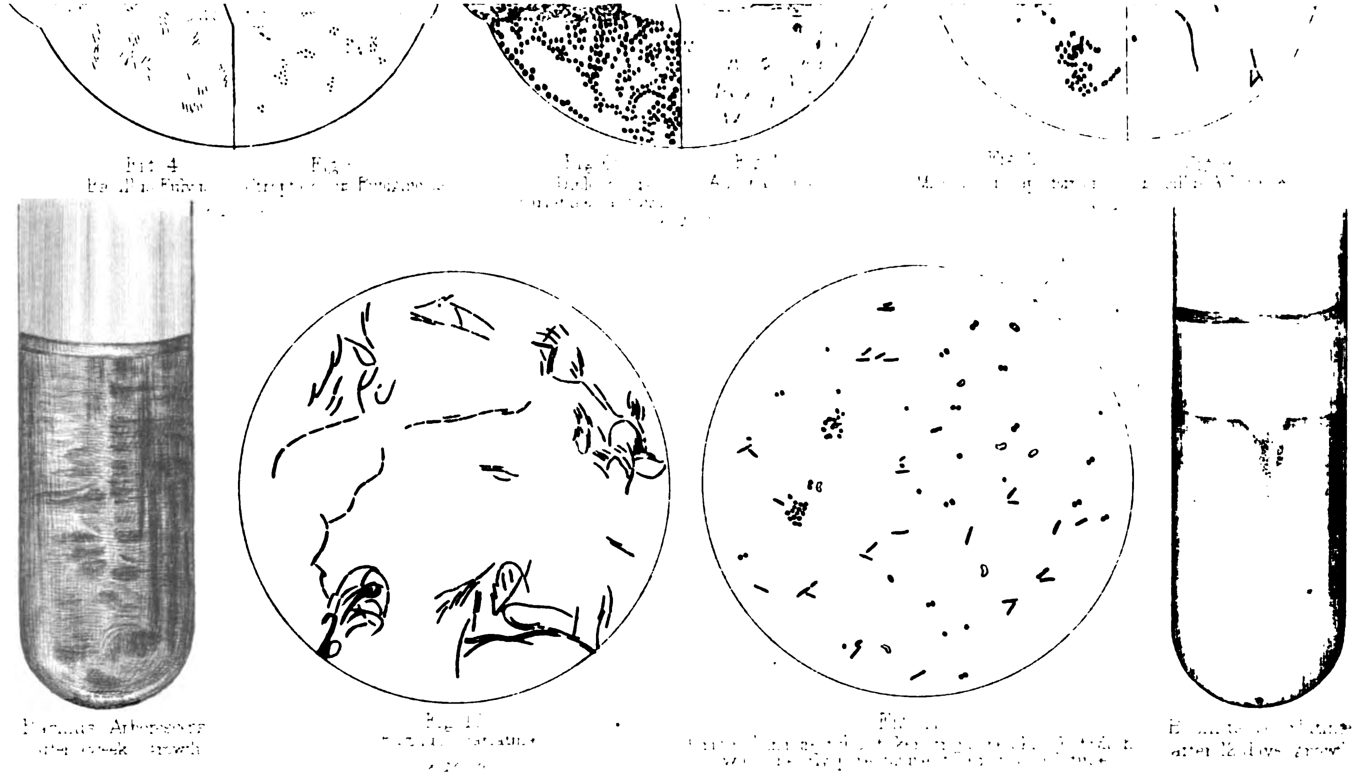








A Method of Prophylaxis and an Investigation into the Nature of the Contagium of Scarlet Fever.

(W. Allan-Jamieson, M.D. and Alexander Edington, M.D.)

From British Medical Journal.

animal's blood. None died. In guinea-pigs the same result obtained; but in them the desquamation was more copious and the flakes much thicker than in rabbits, and the hair came out if taken hold of.

A calf was then inoculated, and at the same time given some of the culture in milk. The calf was in good health at the time, and had a temperature of 99.5°. Six hours from the time of the inoculation the calf developed great sickness, and the temperature taken in the axilla registered 103° F. [This was at 10 P.M.] The calf was then left for the night, but in the morning it was found to have died. In many particulars the autopsy agreed with post-mortem examinations made in the early stages of human scarlet fever.

Small pieces of tissue taken from the spleen and kidney were placed in Koch's jelly and incubated, with the result that the now familiar [to the editor] pellicle formed by this bacillus was developed. So far, then, this experiment and its post-mortem results show that in all likelihood this organism had caused death; and while the state of the abdominal and thoracic organs would imply that the fatal result was due either to a high fever or to blood poisoning, yet the state of the tongue, together with the suddenness of the attack and its rapid termination, suggests scarlet fever.

A second calf was inoculated, when only one day old, with the bacillus, care being taken that the inoculation was made with the absolutely pure material as before, while at the same time the blood was examined with the microscope, and found to contain nothing of the nature of an organism. The inoculation was made in this case with a very carefully sterilized hypodermic syringe. At 6.30 P.M. this was performed, the temperature per rectum then being 99.6°. At 10 P.M. the animal took milk freely, and the temperature remained practically the same. Next morning, temperature 104°; sickness, slight diarrhœa, and complete prostration; throat was in an inflamed condition as far as could be seen. Toward the afternoon the skin covering the thorax, upper part of abdomen, and inner side of the forearm presented a general redness, which toward evening became still better marked. Evening temperature, 10 P.M., 102.8°. The animal now got a little milk. Next morning the animal was still unwell, but the

sickness was almost entirely gone, and it took a little milk. Rash very vivid, especially in the throat. Temperature 101.8°, evening temperature 102°. Throat and posterior part of the tongue very much inflamed. After this time the temperature became practically normal, and on the sixth day of the disease desquamation began on the chest and inner sides of fore limbs.

Further: blood was taken from a case of scarlet fever, on the third day of the fever, with the care previously described, and, to prevent its coagulation, was passed into a tube containing a little liquefied sterilized Koch's jelly. Of this a part was injected into a guinea-pig and a part cultivated by incubation. The guinea-pig developed the erythema as before, with succeeding desquamation, and the tube was found to contain the bacillus and diplococcus. But we have found that the diplococcus sanguinis, as well as the micrococcus capsiformans and streptococcus, while they can exist in the blood for some days, yet of themselves produce no symptoms in the animals. Hence we may conclude that the injection of scarlatinal blood, taken during the period immediately preceding the height of the fever, is, in the case of guinea-pigs, and probably also in others, attended with the same result as the injection of a cultivation of the bacillus itself.

This bacillus is to be seen in the scarlatinal blood, if it be taken during the first two or three days of the fever, and if the cover glasses be spread immediately after the blood is drawn. It is also to be obtained from the desquamation after the twenty-first day of the fever; that is to say, in ordinary cases, when the desquamation begins,—somewhere between the ninth and twelfth day. Of course, in the severest cases, where the desquamation begins earlier, it necessarily follows that we may anticipate its earlier appearance in the desquamation. The editor has examined the blood of some cases from day to day, taking care to control his experiments by performing them twice in the same day, with an interval of an hour or two intervening.

If desquamation be placed in milk kept at a gentle heat for twenty-four hours, the bacilli developed can be recognized by their motility and the pellicle which they soon form. Thus it is evident that if milk be taken as food containing infective desqnamation, the spores will have a perfect nidus and suitable temperature afforded them for development.

From what has been stated it is pretty well proven that this bacillus scarlatinæ is the specific cause of scarlet fever. Probably the other organisms found in the blood during and at a later period than the bacillus, are merely concomitants, and pass into the blood only after the vitality of the system and tissues has been lowered by the entrance into them of this specific organism. But if one injects or otherwise inoculates a perfectly healthy animal with the diplococcus scarlatinæ sanguinis, one finds that it is able to live for some little time in the blood without, in the case of animals, giving rise to any marked symptoms.

The rapidity of the growth of this organism—which is such that if one inoculates a flask of broth, the diameter of which is two inches and a half, and if it be incubated, the pellicle will develop and cover it entirely over in the course of four hours—suggests an explanation of the very short period of incubation in scarlet fever. Hence the particular pabulum in the body suited for its growth may be used up very rapidly, and spore-formation ensue.

By a long course of careful investigations, embodying the results of several thousand cultivations, endeavor has been made to ascertain the specific cause of scarlet fever. These records of such are now placed before the medical fraternity.

Plate Cultivations.—In twenty-four hours, if the cultivation be a fairly active one, we find a few good colonies already liquefied. If such a plate be examined with an objective of low power (seventy-four diameters) it will be clearly seen that in the depth of the jelly are many small colonies growing, but not causing any liquefaction.

After some little time, minute branchings take place, which increase until later on they emerge upon the free surface of the jelly, when liquefaction begins. If, however, we look at a colony already pretty near the surface, we find that it grows to a larger size without showing indications of branching at all. If the observer watch this he will find that very soon a fine halo is thrown out all around the colony, while the central part deepens in color, passing from a greenish-brown tint to that of a brown. This phenomenon usually marks the onset of liquefaction, which begins from the centre.

In one of the plates is seen a colony originally on the free surface of the jelly in which liquefaction has begun early, but in

which the peripheral portion has been able quickly to spread outward. If the first plate be now again looked at we will notice that the older colonies show to the naked eye a double outline, namely, a central circular one, fairly sharply marked out, and an outer irregular one.

Crookshank[3] states that the last link in the chain of evidence in favor of believing that the Hendon cow disease caused human scarlatina was afforded by the researches of Dr. Klein,—that is to say, when it was taken for granted that these researches could be taken without question. Indeed, assuming this evidence to be correct, and attaching to it the cogent arguments brought forward by Mr. Power, such a strong case was made out that the subject appeared to be almost beyond the reach of controversy.

The researches of Drs. Jamieson and Edington, of Edinburgh, which have just been published, have thrown a cloud of doubt over the evidence adduced by Dr. Klein. The Edinburgh research carries with it the weight of considerable authority. Though somewhat incomplete, it appears to be so careful that it cannot be overlooked. On the contrary, an impartial criticism is called for of the evidence brought forward on both sides.

With our present evidence and from a purely bacteriological point of view, we are only justified in concluding that Dr. Klein has isolated and cultivated a streptococcus which is intimately associated with a peculiar eruptive disease of the udders and teats of cattle. That the contagium of scarlet fever may be conveyed by milk, is an accepted fact; but whether this disease in cows is a source of the contagion, is another question.

We have thus brought face to face independent observations on the contagium of scarlet fever, with the perplexing result that neither of the observers finds the special organism described by the other as the specific one. Dr. Klein found and cultivated his streptococcus by the "ordinary methods." A lack of knowledge of these ordinary methods can hardly be supposed on the part of Dr. Edington, which might account for his overlooking of the streptococcus. On the other hand, it is evident that Dr. Klein did not encounter the Edinburgh bacillus in his researches. We must bear in mind in connection with this subject that saprophitic organisms may occur in man, both in health and in disease, which produce very characteristic symptoms in the lower animals.

If they gain access to the circulation through some surface lesion, they may, in an advanced state of disease especially, escape disintegration and be detected in the blood and in the organs after death. Thus they may readily be mistaken for the specific organism, if there be one, of the disease in question. We may also find more than one organism associated with a disease as the result of a double infection. In the organs of children which had died of congenital syphilis, Kassowitz and Hochsinger found streptococci which were regarded as the result of *mischinfection.*

It is interesting to recollect how commonly streptococci have been met with. In addition to those mentioned by the editor, we must bear in mind the streptococci in purulent inflammations found by Ogston, Rosenbach, Krause, Garre, Hoffa, and Biondi; the streptococci found by Weichselbaum in acute pneumonia; the streptococcus isolated by Nicolair from earth; the streptococci found by Emerich in the air; and, we may add the streptococci found by Babes in the liver and kidney in two cases of yellow fever; in the liver, kidney, and spleen in a case of *fièvre typhoïde bilieuse;* and in inflammatory products consecutive to scarlatina; by Bokai and by Babes in joint affections after scarlatina; and by Charrin in septicæmia consecutive to anthrax in rabbits.

In conclusion, obviously the experiments which have been analyzed must be repeated and extended before a definite opinion can be expressed. As in addition to its pathological interest the inquiry involves a question of national importance, it is to be hoped that a commission will be appointed. By testing the result of inoculating blood from human scarlatina directly into the calf and monkey, and by repeating and extending the experiments of Dr. Klein and Dr. Edington, there ought to be no difficulty in dispelling the present contradictions.

TYPHOID FEVER.

The microbe of typhoid fever, such as Eberth and Gaffky have taught us to recognize, is an organism always presenting the form of a bacillus. This is the most constant characteristic of its morphology. In fact, nothing is so variable as its form or even the aspects of its cultures; and this doubtless explains to us the multiplicity of the descriptions made upon this subject during the early years after its discovery. Eberth, Meyer, and Friedländer,

in Germany, Arthaud in France, gave to it the form of an oval, or a shuttle, according to the expression of Arthaud, with clear central space. Gaffky, on the contrary, described a cylindrical rod, and doubted the clear central space. It is probable that it has been the same micro-organism which these different observers have seen; but they have seen it at different phases of its evolution.

The form described by Gaffky is the most frequent, and the typhoid bacillus presents itself in general under the form of a small rod, rounded at the extremities, of a length from 2–3 m., and its length three times greater than its breadth. But these are variable, changing especially with the culture media.

Thus, in simple bouillon the bacilli diminish in length, and appear under the form of an extremely short rod; upon agar and potato the transverse diameter increases. In all cultures in gelatine the rod is seen to lengthen out into filaments, sometimes straight and frequently curved upon themselves. All these forms are represented in the plate. Sometimes also in slides made from the scrapings of the organs, and often upon potatoes inoculated five or six days previous, the editor has met with forms having a clear space, and has seen these forms also appear in old gelatine-tube cultures. The rods are then most frequently swollen in their centre, and it is in this portion that the clear space, which will not take the staining matter, appears. Both extremities, on the contrary, are deeply colored and connected with each other by two lateral lines around the clear space of the centre. In certain cases the bacilli remain slender and very much elongated. The clear space continues then to occupy the greater part of its extent; the colored extremities appearing very small and in the form of a crescent, the concavity of which is toward the centre of the bacillus. The filaments themselves may present uncolored centres, and it is not rare in bacilli of ordinary size to see the clear space appearing no longer at the centre, but quite near the extremity. The plate shows distinctly all of these variations.

The truth concerning the morphology of the typhoid bacillus is, therefore, between the two exclusive opinions of the first observers and that of Arthaud, who, considering the clear space as absolutely characteristic, doubted if the microbe seen by Gaffky was indeed the same as that which he had observed.

If the dimensions of the typhoid bacillus are variable and its

form changeable, it nevertheless presents a constant characteristic of great importance,—that is, its mobility. It is quite peculiar and not likely to mislead when one is skillful in the observation of this microbe. The bacillus of Eberth not only moves across the field of the microscope, but it presents besides an oscillatory movement quite peculiar. There are many species of mobile bacteria, but very few that possess movements similar to those which we have just described. The typhoid bacillus is easily cultivated upon various organic substances. It develops in nutritive gelatine, which it does not liquefy at any period of its development. The culture begins to appear at the end of 48 hours at the ordinary temperature. Along the track of the inoculation puncture in the gelatine tube, small, yellowish, lenticular colonies grow; whilst at the surface a thin, pellicular, transparent disk is developed, with iridescent borders extending toward the walls of the tube; or, on the contrary, a thick opaque growth of limited extent, the size of which does not exceed a small lentil, appears. After inoculations, by scratching the surface of gelatine in an inclined tube the most characteristic cultures appear in the form of a thin, translucent veil, having a nacred, bluish aspect, granular upon the surface, and with irregular, sometimes serpiginous, borders. The growth begins after two days, extends very rapidly, but is arrested toward the ninth day, and the culture never reaches the walls of the tube.

In place of presenting this characteristic development, a culture frequently appears in the form of a very narrow and thick band of yellowish-white color, limited to the inoculation scratches, never spreading out as in the former case. In order to explain this difference in the form of gelatine cultures, certain authors, such as Seitz, attribute it to the variation which unavoidably exists in the composition of the gelatine.

The culture is easily detached from the surface of the gelatine by scraping, and when the colonies are so removed, all that portion of the gelatine previously covered by the colony has become refractory to the culture of the typhoid bacillus. These points may be inoculated with new bacilli, but the surface remains sterile: it is as if it were vaccinated. Upon blood-serum and agar the development takes place readily, and the culture assumes the aspect of a creamy band reaching to the surface of the inclined tube. It has no characteristic form.

On the glycerine-agar of Nocard and Roux the development is surprisingly rapid; it may become very apparent in twelve hours in the incubator. In previously sterilized milk, the micro-organism multiplies and becomes very large.

The potato is a favorable culture soil of the greatest value, which gives the most characteristic reaction. It is the safest criterion for the diagnosis of the bacillus. It lives and multiplies upon it, but without any growth visible to the naked eye. Along the inoculation scratch for several days one can with difficulty see an appearance of moisture, and frequently the cut surface of the potato must be examined at a certain angle of incidence in order to discover the presence of a culture. When the potato is very moist at the point of inoculation, one distinguishes upon the cut surface a slight swelling, the appearance of which reminds one of the sugared surface of certain cakes. This appearance is at times so slight that it may pass unperceived by an experienced eye; it is, moreover, much rarer than the first. One cannot insist too much upon the value of this form of culture upon the potato, for the presence of the micro-organism should never affirm without resort to this test. The microbes which do not grow upon the potato more visibly are exceedingly rare. Those of erysipelas present this characteristic; but there can be no confusion between these two organisms, the microbe of erysipelas being always a micrococcus. Inoculated upon alkaline potato pap in a flask placed in the incubator, the bacillus develops without showing an apparent culture for a certain time; but after fifteen days the surface of the dried pap assumes a dark color.

The typhoid bacillus grows very well in vacuo, according to the experience of Dr. Roux as well as that of the editor. The form assumed by the colonies upon the gelatine plates inoculated after the method of Koch is worthy of a detailed description. This method enables one to isolate the typhoid germ from other microbes and to recognize it in water, fæcal matter and urine. Two or three days are necessary for the appearance of their colonies. In typical cases the colonies are as broad as the head of a large pin, thin, pellicular, nacred, transparent, and during the following days, notwithstanding the increase of volume, the transparency and the bluish tint persist. At the end of five or six days they have reached the size of a lentil, their contour has

become irregular, indentated like the shores of an island, thinner in general than their centre, and their surface has become granular. Examined under a low magnifying power (obj. 0 or 1 of Verick), they appear permeated throughout their whole extent by more or less marked ridges, sometimes arranged in a rectilinear manner like the veins of a leaf. Sometimes their surface is more irregular, and the whole colony seems formed of convolutions like those of the small intestines twisted upon themselves. The combination of these two aspects, joined to the brilliant color of the whole, sometimes give to the colony the appearance of a mountain of ice.

This form is far from being constant, and one cannot repeat too often that the culture of the typhoid bacillus upon gelatine is essentially polymorphous. Often, in fact, the plate-colonies remain small, distinct, circular, regular upon their surface, as also in their contours. Then they have no characteristic distinct from a number of germs which grow in all organic media. They have in this case remained in their first phase of development. When the colonies begin to form, they always present this form of a small circular disk. By further growth they seem to become fragmented. The lines, penetrating from the periphery toward the centre, sink into them, and the contours assume a sinuous shape. These deformities are accentuated in proportion as the colony is developed, and after a series of transitions the appearance ends by acquiring the characteristic which we have already described. The plate shows all these forms of development. When plates are made with old cultures, it happens that the colonies, even when they have sufficient room to extend, remain in the state of a small circular disk, arrested in their development in accordance with the fact, already pointed out by us, that the typhoid bacillus loses its vitality in proportion as the cultures become old.

The difficulty of examination of the colonies in plate cultures is due, therefore, to their polymorphism. We will endeavor to establish their differential diagnosis from other colonies. It is necessary to exercise an extreme prudence in examining typhoid bacilli in any media. The form of the colony in plate cultures is the sole guide to its recognition; but this can be deceptive. Prior to affirming the presence of the pathogenic agent, it is absolutely necessary to demonstrate the morphological characters and the peculiarities of culture already pointed out.

Sporulation, when it can be recognized, furnishes also a valuable confirmation to the diagnosis. The degree of temperature most favorable to the culture of the typhoid bacillus seems to us to vary between 25° and 35° C. The growth of the inoculated germs diminishes when the temperature is lowered. It still takes place, however, at 3° C., as the experiments of Seitz have proven. The resistance to cold is very great; for the editor submitted to the cold of this winter bouillon tubes previously inoculated and kept in the incubator between 25° and 30° C., without the microbes having been destroyed. The vitality of the bacilli persists for a long time in culture tubes. From all that we have said concerning the culture and sporulation of the typhoid bacillus, concerning the influence of temperature upon its vitality, it follows that the microbe of Eberth and of Gaffky possesses a great power of resistance to all the causes of destruction. This explains the ready transmissibility in every season by organic matter, and explains also the persistence of the causes of typhoid infection in soil and in the air.

Inoculation into Animals.—Before undertaking any inoculation of animals, one could form the supposition *à priori* that this sort of typhoid infection would be difficult to obtain. We do not know in reality a single species of animals which acquires typhoid fever spontaneously. Veterinarians have never yet demonstrated the characteristic lesions of typhoid fever in mammiferæ. Domestic animals, subjected as much as ourselves to all the causes of unhealthiness by means of food, water and air, appear to be entirely refractory to this virus.

Consequently, if the typhoid infection can be produced in the animals, it can only be done by overcoming their power of resistance through the introduction of large doses of the virus, and through the inoculation of the typhoid germs free from every excipient. This explains how the attempts made previous to the discovery of the typhoid bacillus and of its pure culture have only ended in unsatisfactory results in which infectious principles foreign to typhoid fever played the principal rôle.

Chantemesse and Widal undertook inoculation experiments upon various animals, and have obtained positive results in the main confirmatory of those of Fränkel and Simmonds, A. Fränkel and Seitz. During the course of their experiments they had the

opportunity to observe the bacilli of typhoid fever in the liver and spleen of the fœtus of a female guinea-pig which had aborted 48 hours after the inoculation. This observation is in accord with clinical experience. The authors spoke of having obtained the bacillus of typhoid fever from the human placenta, and referred to the recognition of it in the liver and spleen of a fœtus by Neuhauss.

It is already known that Brieger extracted from old cultures of typhoid bacilli very poisonous alkaloid which he called typhotoxin.

Sirotinin instituted a series of experiments to study the toxity of a culture of typhoid bacilli after its sterilization, and concluded from them that the cultures of these bacilli, whether the latter are removed by sterilization or filtration, produced in the animals the same phenomena as do the living cultures. The success of the experiment depends upon the quantity of the matter injected and the chemical constitution of the culture media as well as upon the age of the culture.

Explanation of Figures of Plate.

Figs. 1 and 2. Peptone-gelatine tubes inoculated with a drop of blood taken with sterilized trocar from the spleen of a person attacked with typhoid fever on the tenth day of the disease. The cultures contain only a single species of microbe, the bacillus of Eberth.

Fig. 3. Colonies of typhoid bacilli at the commencement of their development in peptone-gelatine plates. The most recent are bright, round, transparent; those of a more advanced age show at their periphery the commencement of small ridges.

The colonies have not at this period of their development any typical character. They may be confounded with colonies of many other microbes.

Fig. 4. Colony four days old as seen with diffused light. The illumination is not intense, and the better allows of the recognition of the ridges and the grooved and tortuous surface of the colony. To the naked eye, such colonies upon gelatine-plates appear as a thin, bluish pellicle, easy to distinguish from all the others. If the light be more intense, the whole colony assumes the metallic reflex of a mountain of ice.

Fig. 5. Colony six days old: the central part is slightly elevated. This is an appearance of typhoid bacilli very rarely observed. It most frequently appertains to common microbes which live in the colon.

With respect to the illumination, same observations as for the preceding figures.

Fig. 6. Typhoid colony eight days old, seen by diffused light.

Fig. 7. Bacilli of Eberth after a culture of three days upon peptone-gelatine.

Fig. 8. Central clear space appearing in the bacilli from a culture upon potato, four days old.

Fig. 9. Monstrous forms which are met with in very old cultures upon potato and especially upon gelatine. The mobility persists and the microbes are less agile than in the short forms represented in Fig. 7.

Fig. 10. Typhoid bacilli spores. These spores should not be confounded with the clear space represented in Fig. 8. They are located at the extremity of the bacillus which preserves its ordinary length. The spore is slightly ovoid; they are not clouded by the usual staining methods; their enveloping membrane, however, takes a very slight tint, which allows its size to be appreciated.

Typhoid Bacilli in the Blood.—The results of investigations of the blood for typhoid bacilli have been contradictory, but Reütimeyer[1] approaches the question with the employment of all necessary precaution. The blood was taken from the spots of the eruption.

Of six typhoid cases, one of the first week and five in the second, sixteen original cultures were made from thirteen different spots by about fifty-five punctures. Fifteen of the original cultures remained sterile, and in only one culture from two punctures there developed itself in the course of some weeks a small grayish spot which the microscope showed to be composed of bacilli, presenting the character of typhoid bacilli. While these results are of general interest, yet for diagnostic purposes they can only apply to a few cases.

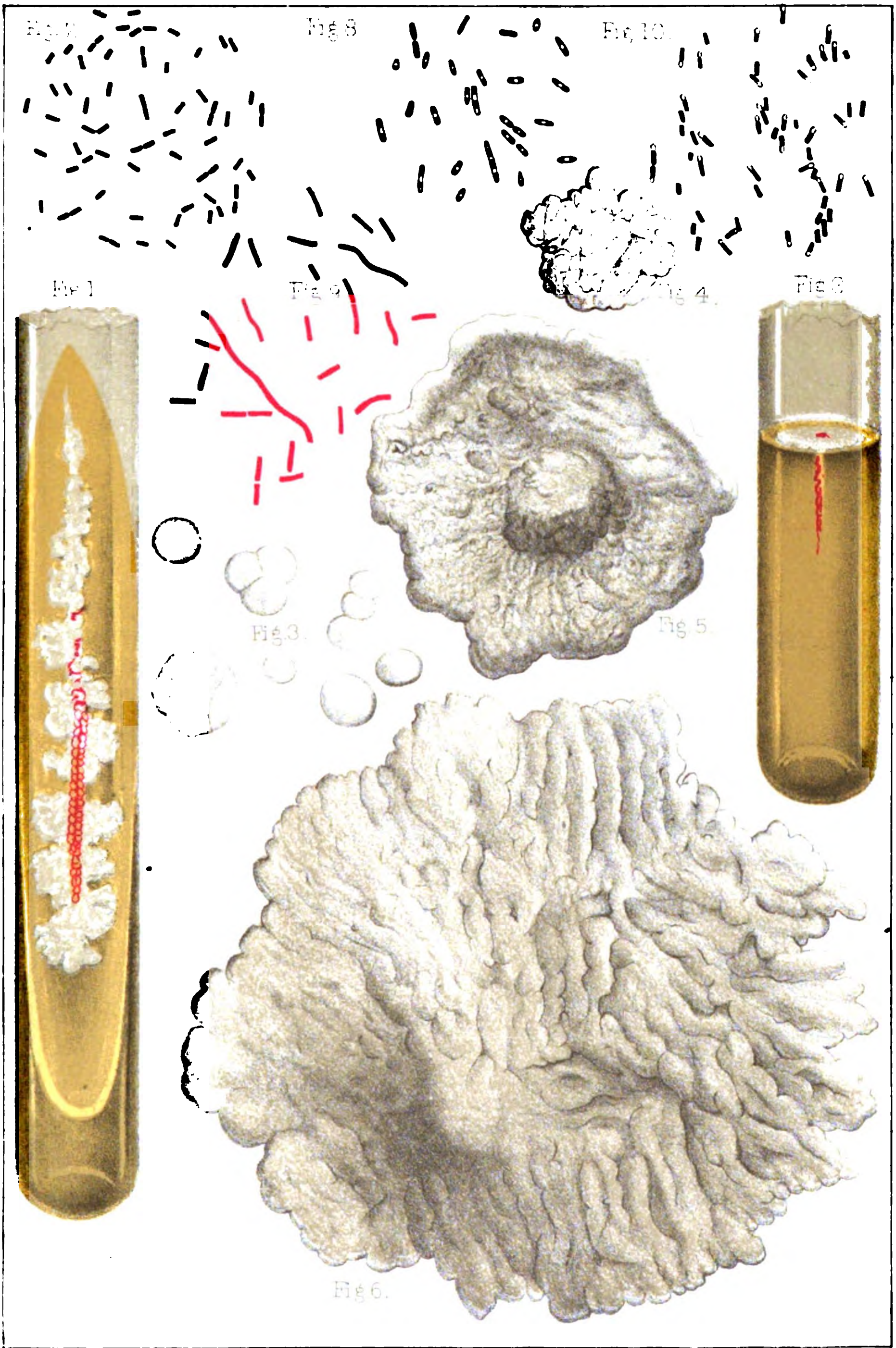
MERCURIAL PARALYSIS.

Letulle[13] has published an interesting paper on this subject. After discussing the resemblances and differences between saturnine and mercurial paralyses, and pointing out experiments necessary to demonstrate the existence of nerve lesions caused by the mercury, the technique is explained by aid of which the author compared healthy with intoxicated nerves and studied the direct action of mercury placed in contact with the nerve tubes.

Lesions Observed.—The number of altered nerve tubules is in direct proportion to the duration of the experimental intoxication. The mercury absorbed by the organism determines in the nerves three orders of distinct lesions, probably consecutive, but capable of coexisting in the same subject and of being seen even upon one and the same nerve tubule. These mercurial lesions of the nerve are segmental and periaxile. They consist in:—

(1) pale tumefaction of the myeline; (2) granular disintegration; (3) segmental atrophy. The variable condition of the various consecutive portions of the interannular segment as to those different phases.

Conclusions.—Mercury has a diatrophic action upon the myeline, of which it alters the chemical constitution. Lesions which it produces are not inflammatory, and they seem to spare indefinitely the cylinder.



Archives de Parasitologie

G. Masson Edit. Paris

EXPLANATION OF THE FIGURES OF PLATE X.

Fig. 1. Healthy nerves of a young guinea-pig, prepared after the method of Vanlair and mounted in balsam after staining with hæmatogyten. *A. B.* Nerve-tubes showing at *e* the annular constriction colored slightly red and allowing the vertical course of the axis-cylinder to be seen by the orange-red tint which it has assumed in the staining; *m*, dark brown layer of myeline, in which some darker spheres are visible, as at *b*. *C.* Healthy nerve tube in which the sheath of Schwann, probably distended by the coagulatory fluids, forms at *s* a distinct bulging. *D.* A fine nerve tube, rendered moniliform by the hardening. The thin layer of myeline which covers it of a pale yellowish gray; *n* is an interannular nucleus sligthly tinged pale rose.

Fig. 2. Nerves subjected to the local action of mercury (injection of mercurial peptone); examination on tenth day: *A.* Several nerve tubes seen under a low magnifying power; the myeline, broken up into a mass of sut-like particles, shows in sharp contrast against the rosy sheath of Schwann. At the centre of each nerve tube is distinctly seen a distinct bright red line, which represents the denuded axis cylinder. *B.* An isolated nerve tube, viewed under a higher power: *mm*, minute globules of myeline; *s*, empty sheath of Schwann; *cy*, denuded and normal axis cylinder. *C.* The same nerve tube seen under still higher magnifying power. In it one sees: *n*, the isolated normal interannular nucleus; *s*, at this point the sheath of Schwann appears swollen, although it is absolutely empty of myeline.

Fig. 3. A nerve tube examined on the third day of a mercurial intoxication, and showing a granular (sable) condition; *m*, a considerable number of small black points are disseminated through the pale myeline; *b*, globules of coagulated myeline having the usual size; *n*, the normal nucleus of the segment; *cy*, the axis-cylinder visible in the vicinity of the annular constriction.

Fig. 4. Nerves of a guinea-pig dead on the eighteenth day. *A.* Healthy nerve tube, differing, however, from the healthy nerve tubes of Fig. 1 by a more brilliant rose stain. The layer of myeline is normal. *B.* Differs from the preceding by the pale rose tint of the myeline which permits the axis-cylinder, colored orange-red, to be seen throughout almost the whole length of the segment. Some globules of pale gray myeline are visible. *C.* Same appearance as for the preceding nerve, with this difference, that the myeline seems more swollen and darker. The globules of myeline are darker and axis-cylinder is less visible. *D.* Here the myeline, in segment subjacent to the letter *m*, appears as a dark, purulent mass, in the course of which, however, the axis-cylinder, *cy*, can here and there be seen (granular disintegration).

Fig. 5. Nerves from a rat dead on the forty-sixth day. Except the nerve *g*, which is a fine nerve tube adjacent to the three sections which belong to one and the same nerve tube. The sections consist of four consecutive interannular segments, and show a segment attacked with "pale tumefaction" and isolated between two normal segments. *m′m″*, continuous portions of these nerve tubes; *n*, normal nucleus of the segments; *t*, pale and swollen myeline extending through the whole length of an interannular segment. This peculiar condition of the myeline, on account of its transparency, allows the slightly sinuous course of the normal axis-cylinder to be seen. *r*, globules of the myeline, or fragments of the less altered myelinic sheath. *m*, normal sheath of myeline.

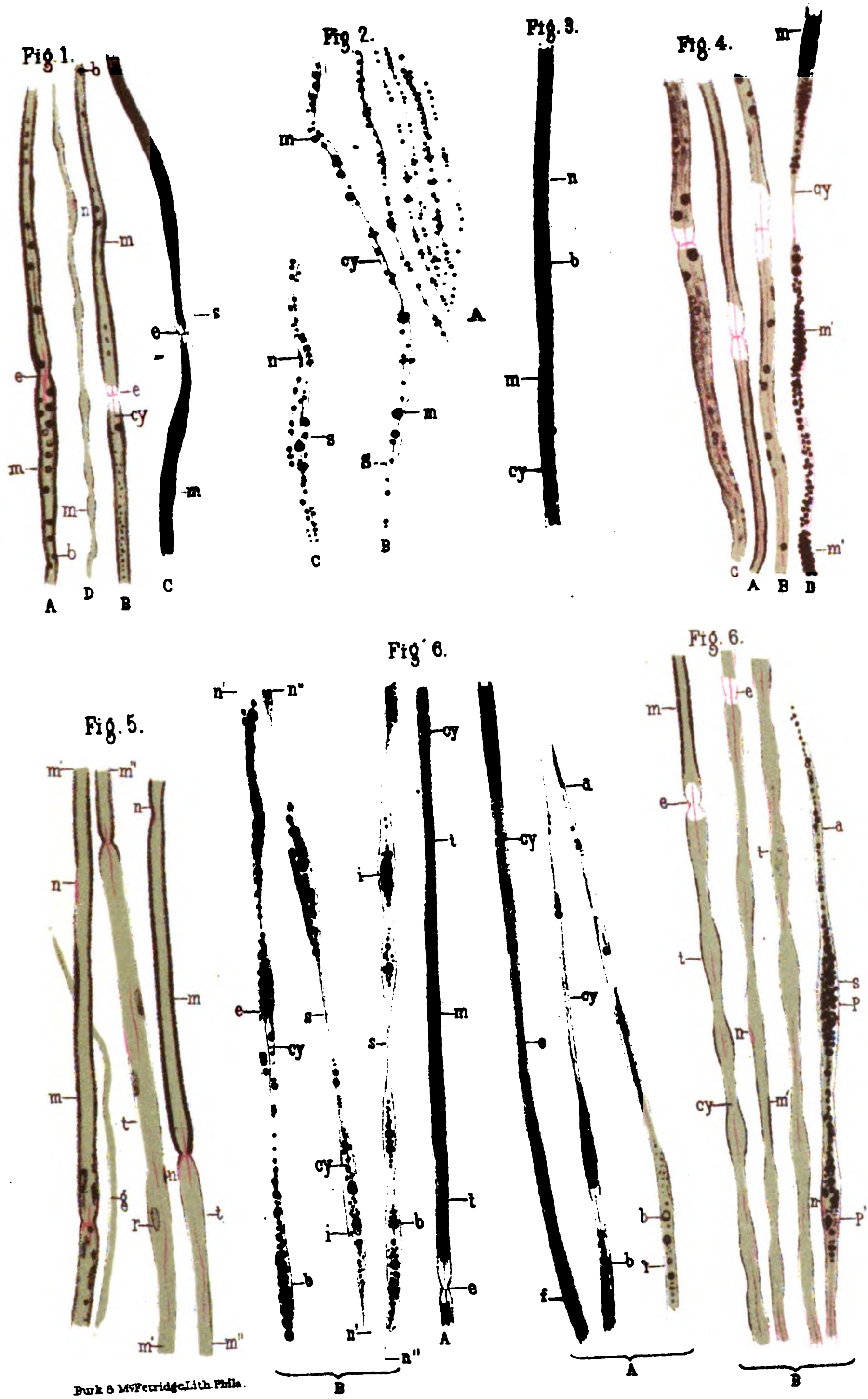
Fig. 6. Two nerve tubes from a rat dead on the twelfth day. *A.* Interannular segment, of which the myeline is altered at both extremities; *m*, the normal portion; *n*, nucleus of the segment, in the vicinity of which the myeline is not attacked; *t* points where the less dark and more rose-colored myeline has undergone cloudy degeneration, without the formation of isolated globules. *B.* A nerve tubule followed throughout its whole length, the fragmented myeline of which leaves the axis-cylinder denuded in several places; *n′ n″*, continuous points of the same nerve tube; *i*, fusiform portions in which the myeline is in the pulverulent condition or forms globules of variable color and size; *b*, pale or dark globules of myeline;

cy, axis-cylinder; *s*, sheath of Schwann empty of myeline and not showing the axis-cylinder distinctly; *e*, annular constriction still visible.

Fig. 7. Nerve taken from a guinea-pig on the eightieth day. *A*. Nerve tube along the course of which can be successively followed the state of cloudy disintegration, fragmentation of the myeline into globules, segmental atrophy of the nerve tube, total disappearance of the myeline, and finally the relative integrity of the axis-cylinder: *m*, point where the layer of myeline seems to be still almost normal; *t*, cloudy alteration of the myeline in process of atrophy; *f*, fragmentation of the myeline, but very apparent preservation of the axis-cylinder; *b*, globule and angular fragments, myeline variously tinted; *a*, atrophied portion of the tube, where every trace of the myeline has almost entirely disappeared; *cy*, axis-cylinder, visible and denuded at points. *B*. Nerve tube showing in its continuity various segmental lesions, especially the state of "pale tumefaction" and granular disintegration: *m*, normal nerve tube; *t*, consecutive interangular segments having undergone cloudy swelling of the myeline; *m'*, a portion of the segment, near the nucleus *n*, where the myeline has a normal appearance, although it is slightly pale red; *cy*, the axis-cylinder is easily followed through these cloudy segments rendered moniliform by hardening; *p*,—at this point an entirely different change begins—the granular disintegration, very marked at *p*, in the neighborhood of the segmental nucleus; *n*, segmental nucleus not at all proliferating; *s*, sheath of Schwann very visible at certain points, especially at *a*; *a*, point where the segmental atrophy becomes evident; *e*, annular constriction.

STRUGGLE OF CELLS OF THE ORGANISM AGAINST INVADING MICROBES.

Metschnikoff,[5] in discussing the struggle of the cells of the organism against invading microbes, gives the name of "phagocytes" to the cells that possess the property of absorbing and digesting microbes. The action of these cells is not confined to the absorption of dead or degenerated tissue. They also furnish the organism with a means of resisting microbes which may have penetrated into the tissues. Metschnikoff made his researches on transparent animals, such as the daphnea, which are found invaded by a parasite of the higher animals. The spores of this parasite penetrate with the food into the intestine, from which they escape into the cavity of the body of the daphnea. As soon as they have so done a struggle commences between them and the white corpuscles, which, isolated or in groups, absorb the spore and destroy and transform it into shapeless granules. The daphnea is thus saved. But sometimes (about one time in five) the spores escape the white corpuscles. They then germinate and a considerable number of conidia invade the body of the animal and kill it. But even when the spore has germinated the struggle does not cease; for the white corpuscles continue to absorb some of the conidia, which, however, are so rapidly developed that the phagocytes are powerless to overcome them.



Lesions of Mercurial Paralysis. (Letulle)

Archives de Physiologie, G. Masson, Pub. Paris.

Metschnikoff adds that in the higher vertebrates and in man there is also a struggle between the microbes and the cell elements; but the phenomena are more complicated as there are two species of phagocytes. The first, leucocytes, are scattered through all the tissues and concentrated in the lymphatic and circulatory glands. He calls them "microphagi;" and he gives the name of "macrophagi" to the connective tissue corpuscles, the epithelial cells of the pulmonary alveoli, and in general to all those cells that are capable of absorbing solid bodies and are provided with only one large nucleus. They are not so easily colored as the microphagi. But, as Metschnikoff points out, there are cases in which the organism is invaded by microbes without any resistance being made by the phagocytes. These are cases in which the animal is in a diseased condition, as in the cholera of fowls. In this case death is generally rapid. The same micro-organism inoculated on the guinea-pig produces only local infection, and the animal generally recovers. In this case the mass of pus cells surrounding the point of inoculation is found to contain a quantity of microphagi full of the absorbed bacteria of foul cholera. In carbuncle the microphagi are powerless to absorb the bacteridia. The case is otherwise, however, when, instead of a strong virus, the attenuated virus obtained by the method of MM. Pasteur, Chamberlain and Roux is employed. When the virus is introduced beneath the skin of the animal, a large number of microphagi surround the bacilli of the vaccine, which are thus destroyed in the interior of the phagocytes. The same thing happens after a second inoculation. Metschnikoff employed in his experiments a watery solution of vesuvine, which does not color living bacteria, but stains dead ones brown. In this way he saw most of the rod-shaped organisms, encased in the protoplasm of the microphagi, assume a brown color; whereas the cells remained colorless and continued to live, showing amœboid movements. After remaining for some time within the white corpuscles, the bacteria become difficult to see. Experiments made with frogs kept at a temperature below 20° C., gave similar results. On the day following inoculation large numbers of bacteridia were to be seen colored by vesuvine; and on the following day all the bacilli had been absorbed by the microphagi, and many were already in the course of destruction.

Dr. Ecklund, our Corresponding Editor, states that Holmfeld, in researches made upon anthrax in the rabbit, the mouse, and the rat, demonstrated that this theory cannot be sustained to the full extent of the claims of Metschnikoff. The species of animals above mentioned were chosen for the experiment because of the relative difference between them as to their susceptibility to the disease in question; and the object of the experiments was to demonstrate the different local and general influences which the inoculation into the animals of different susceptibility produces.

Hypodermic injection of a very small quantity of anthrax bacilli into rabbits and mice (animals which are very susceptible to this disease) produced at point of inoculation an extravasation of plasma into the wound. On microscopic examination of this fluid, a considerable quantity of anthrax bacilli were found, but almost no white blood-corpuscles. Here and there the author has met with white corpuscles which contained bacilli,—Metschnikoff to the contrary.

Adult white rats are not susceptible to anthrax and possess immunity against this disease; but the following phenomena were met with after subcutaneous innoculation of a small quantity of anthrax bacilli. 24 hours after the inoculation there was in the wound a pure pus containing many bacilli, which were sometimes met with in pus cells, but in most cases were free in the fluid. 48 hours after the inoculation the bacilli were distributed through the fluid of the pus without being devoured by the corpuscles. 24 hours still later the bacilli were generally dead,—a fact which is proved by the negative results of injections of the pus into mice and the inoculations of Koch's culture material (agar and gelatine). The bacilli were really killed in the pus without previously being devoured by the corpuscles, as proved by the following experiment: Pus from the point of inoculation of a white rat, inoculated 24 hours previously with the bacilli of anthrax, was drawn up into a very fine glass tube. The tube, sealed at both extremities, was placed in a thermostat at 36° C. Every 12 hours a little of the pus contained in the tube was inoculated into agar and also injected into a rat. The result of this experiment showed that the bacilli were dead from 72 to 96 hours after the inoculation.

In young rats, which died about eight days after inoculation with anthrax, the suppuration was not so pronounced as in adult

rats. Nevertheless many pus cells were found in the fluid of the wound, and among them the cells frequently contained bacilli. In rabbits inoculated with non-virulent cultures of anthrax (attenuated after the method of Pasteur), the inoculation caused suppuration, as in the adult rats. In these cases the majority of the bacilli were entirely free in the pus. A very few were also found in the corpuscles.

The experiments showed that the theory of Metschnikoff is not entirely in accordance with the facts. Not only may the pus cells of the animal susceptible to the disease in question contain microbes and the animal die of the disease (rabbits, mice, young rats), but also the microbes inoculated into animals enjoying an immunity (adult rats, rabbits inoculated with attenuated anthrax virus) may not always be devoured by the pus cells. On the contrary, the majority die in the fluid of the pus without being devoured by the pus corpuscles.

These experiments showed, moreover, that the suppuration is of great importance as regards immunity of animals toward infectious diseases, and that it ought to be regarded as an advantageons reaction of the organism against the invasion of the pathogenic microbes.

C. Garré, of Basle, has found that in cultivation there is a very sharp antagonism amongst some micro-organisms, probably through their excretions. For instance, some ærobes, which spread only on the surface of gelatine, in a short time so alter the nutritive substratum that certain other micro-organisms can not exist in it. He says that as yet this fact has not been considered.

Various observations made in the cultivation of cholera and typhoid bacilli and the experiments on the multiplication of the pathogenic bacteria have shown the probability of antâgonism between the pathogenic species and the sapprophitic. To elucidate this, Garré adduced the following facts: A non-liquefying cultivation was planted on the surface of meat peptone gelatine. After complete development it was removed with a sterilized platinum spatula. Other micro-organisms were then planted on the remaining sterilized medium. A comparison of the retarded growth with another cultivation gives the degree of antagonism between the two species.

With liquefying species, the nourishing substratum was filtered through porous earth and gelatine added afterward. In this way the mutual relations of a number of pathogenic and non-pathogenic species were tested. One species proved to be permanently antagonistic, namely: Bacillus fluorescens putridus, described by Flügge. It excretes specific, easily diffusible substances, the oxidation products of which tinge the gelatine with a greenish color and hinder the development of the one set of species, whilst it has no effect whatever on the other set. If such cultivations were removed from the gelatine in the manner described, on the third or fourth day, and the staphylococcus pyogenes aureus inoculated on this "fluorescent medium," no development took place; nor did the typhoid bacillus or pneumonia bacillus, etc., develop. The Asiatic cholera bacillus and the bacillus mycoides developed but slowly; but the bacillus anthrasis and the common hay bacillus had a luxuriant growth. It appears therefore, that the bacillus fluorescens putridus is a pronounced enemy to the pneumonia and typhoid bacillus, and by its growth the nutritive substratum is protected against them. The reverse, nevertheless, does not hold good. There are, however, so-called symbiotic bacteria that flourish side by side, and some which Garré terms metabiotic bacteria, whose existence depends on the presence of others.

Garré asserts that these facts are not confined to experiments in test tubes. He points to the strife between sapprophites and cholera bacilli in ichor and canal water,—the cholera bacilli succumbing. Such conditions may occur in the intestines, and may in some cases lead to the erroneous supposition of a natural indisposition to cholera. The torpid development of periostitis of the jaw, when the staphylococcus must come into conflict with other species, is explained by Garré on the supposition of such antagonism. He closes with the following points as regards immunity:—

(1) That immunity from a certain disease may be caused by micro-organisms of like species (vaccination), and also by entirely different species.

(2) Antagonism quickly produced in the living body may favorably affect infectious diseases already existing. If this be true, a wide and fruitful field is opened to bacterial treatment.

After a series of experiments, Pawlowski[7] comes to the conclusion that the cure of anthrax by means of bacteria is possible. It is attainable by means of numerous subcutaneous injections of different micro-organisms into or around the point of entrance of the anthrax bacilli. The most powerful antagonist of the anthrax bacilli is the diplococcus pneumoniæ fibrinosæ of Friedländer: in the experiments with it, all of the eight rabbits treated recovered. The next powerful is the staphylococcus aureus: all four of the rabbits treated by subcutaneous injections were cured. Local anthrax may be cured even with the non-pathogenic micro-organisms; for the bacillus prodigiosus occupies the third place of importance in his investigations. A single subcutaneous injection of bacillus prodigiosus is not sufficient; but a second one causes complete recovery: of ten rabbits, eight recovered from the anthrax injection, particularly those in which subcutaneous suppuration at the point of injection of the bacillus prodigiosus was observed. Finally, the fourth place in the power to cure local anthrax is occupied by streptococcus erysipelatosus: of seven rabbits, two died.

Regarding the cure of general anthrax through intravenous injections, the author obtained favorable results only by an injection of the anthrax bacilli and the diplococci of pneumonia together. In this case, of seven rabbits two recovered, three died of embolism, and two of anthrax. Finally, by injection of anthrax bacilli and afterward diplococci, not a single one of the five rabbits recovered; but the struggle of the organism with the anthrax bacilli was lengthened out much longer than in the case of simple injections of anthrax bacillus. Two rabbits out of the five experimented upon did not die between thirty-six and forty hours, but only after seven and fourteen days respectively. Injection of staphylococcus aureus into the blood did not save the animals from anthrax. By the injection of the cocci of erysipelas and bacillus prodigiosus into the blood, the struggle with the anthrax bacilli was prolonged; but the animals finally died. Many animals succumbed after the injection of the erysipelas cocci in from three to five days, and of bacillus prodigiosus in from four to seven days.

Von Emerich and Mattei[8] believe that we are now in a position to treat anthrax even more successfully than the results communicated indicate. In the struggle in the organism between

the anthrax bacilli and the erysipelas cocci, as in every struggle, the number of the combatants plays a very important rôle. Pawlowsky in his experiments according to these authors, entirely left out of consideration the numbers of the micro-organisms, and by this circumstance alone is the fact to be explained that he was less fortunate in the cure of anthrax than they; and that he, for example, obtained more favorable results with pneumonococci than with injections of erysipelas cocci.

Some experiments were undertaken for the settlement of the question as to whether or not the blood of the animals previously inoculated with erysipelas cocci is capable, outside of the animal body, of destroying anthrax bacilli. Specimens of blood, 2 to 5 cc. in quantity, were under all precautions removed from animals previously injected with erysipelas cocci and were inoculated with anthrax bacilli and kept at a temperature of 36° C. in thermostat, and were daily examined with a microscope. In them were to be seen very many bacilli in a state of degeneration, and many very long filaments showing a finely granular metamorphosis,—changes which are never seen in anthrax bacilli when added to normal blood. This deleterious action of the blood of rabbits previously inoculated with erysipelas was, however, so limited that it was insufficient to cause the destruction of all of the anthrax bacilli in any of these specimens.

The results of the experiments of the authors are as follow:—

Whilst simple anthrax infection, with an extremely small amount of anthrax cultures, secures the death of the animal by anthrax in a few days, yet the previous injection of erysipelas—that is to say, previous presence of erysipelas cocci in the connective tissue of the body—prevents not only death by anthrax, but also development of any appearance of disease. Neither the œdema at the point of injection so frequently seen in the anthrax rabbits, nor the swelling or other changes of the spleen take place. Whether or not a few or many million anthrax bacilli are injected subcutaneously into animals previously inoculated with erysipelas cocci, all of these anthrax bacilli are destroyed within seventeen hours.

The penetration of the anthrax bacilli into the lymph and blood-vessels and into the organs does not take place. The bacilli

are killed at the point of injection into the subcutaneous tissue. In a communication concerning immunity and phagocytosis, Christmas-Dircknick-Holmfeld[6] demonstrated that in subcutaneous injection of anthrax bacilli under the skin of animals made immune by previous inoculation, the anthrax bacilli are destroyed at the point of injection. Therefore the disease remains localized and limited to this point.

Whilst Holmfeld believes that the anthrax bacilli are killed by means of the formation of pus at the point of injection, and that the suppuration comes to play the chief rôle in the infectious diseases of the different animals showing variable susceptibility, we must object that generally in injection of anthrax bacilli after previous inoculation of erysipelas not a trace of suppuration at the point of injection is to be observed. The same is the case in rabbits protected against hog cholera (schweinerrothlauf) when one injects into them a large number of virulent bacteria. In this case the destruction of bacilli in the subcutaneous tissue at the point of injection is even more rapid (four to five hours), but at the same time without suppuration. Result of the experiments will soon be published.

How are the bacilli killed in the subcutaneous connective tissue in so short a time?

We are of opinion that the phagocytes play no rôle here; that they rather swallow the already dead bacilli and remove them from the body. The destruction of the anthrax bacilli by previous inoculation of erysipelas doubtless takes place through a chemical poison for bacteria which is produced by the cells of the body. That it is not by the material produced by the bacteria that they are killed in the body, is proved by the rapid destruction of the hog cholera bacilli in the body of animals which have been made immune. The destructive process of the bacilli begins at once after the latter are introduced into the body, and terminates in from four to five hours.

It is manifest that the substance which kills the bacteria is produced by the cells of the body of immune animals; and it is probably always present in the body of these animals. Very improbable is the conjecture that the formation of this substance takes place through the action of the bacilli injected into the body of the immune animal.

The irritation of the first injection of hog cholera bacilli causes permanent alteration in the function of the cells of the body. In the organism of non-immune animals, an unusual irritation of the hog cholera bacilli upon the cells of the body occasions the production of alkaloids, poisonous to the cells of the body, but harmless to the bacteria. The cells of the body of immune animals, through modifications which the first infection left behind, upon the same irritation produce alkaloids, non-poisonous to themselves, but poisonous to the bacteria.

In this direction we must advance to attain the means of cure of these infectious diseases.

ANTHRAX.

Dr. L. C. Woodbridge[2] recently communicated to the Royal Society a method by which he had been enabled to protect rabbits from anthrax,—which is of considerable interest in connection with the general question of the nature of protection in this and other diseases depending on micro-organisms. The method consists in cultivating the anthrax bacillus in an alkaline solution of a peculiar proteid body which can be obtained from the testis and thymus gland. The growth is not abundant; and after two days, at 37° C., the bacteria are removed from the culture fluid by filtration. If a small quantity of this fluid be injected into the circulation of a a rabbit, the animal can then withstand the inoculation of extremely virulent anthrax blood. The bacillus itself grown in this culture field has no protective influence. It either kills or has no effect.

The result is extremely curious; for hitherto protection against zymotic diseases has been effected by the communication to the animal of a modified form of the disease against which protection is sought. In Dr. Woodbridge's experiments protection must be produced by some chemical body, the product of the activity of the bacillus. The observation belongs to a new order of facts, and appears to fall in with Pasteur's theory as to the method in which immunity to hydrophobia is produced by inoculation of the spinal cord of rabbits. Both find some support in Prof. Cash's experiments with perchloride of mercury, in which it was shown that after animals had taken a sufficient quantity they were no longer liable to anthrax.

LIQUEFACTION OF GELATINE BY BACTERIA.

One character common to numerous micro-organisms, and which Koch was prompt to seize upon as valuable in defining specific characters, is the power of liquefying gelatine.

So far as Sternberg[8] is aware, no satisfactory explanation of the cause of the liquefaction has been given. Yet it is evident that it is connected with the growth of the liquefying organism.

During recent experiments upon the thermal death-point of pathogenic organisms, the author ascertained that this liquefaction is due to a soluble chemical product which is formed during the active growth of the liquefying organism, and that an apparently small amount of this substance will liquefy gelatine, independently of the living organism.

PATHOGENIC ORGANISMS IN SPUTA.

Biondi[11] took sputa from fifty persons, some in health, others ill, and injected it into animals. When pathogenic results followed, the tissues were searched for micro-organisms. These were cultivated and isolated. He found five different kinds. Of these, the *bacillus salivarius septicus* was found in 20 per cent. of the sputa examined, and it was found most abundant in the sputa secreted before midday. Dogs and mice into which 0.5 to 1 cc. of sputum was injected, died in the course of 24 to 72 hours. Before death there was usually fever, sometimes also continuous coma. In some cases death did not take place till after the lapse of 30 days, the animals gradually emaciating, and the hair falling out, etc. After death œdema and hæmorrhage were found about the point of infection as well as in the parenchymatous organs and serous cavities. The spleen was swollen and the micro-organisms were found in the blood.

Biondi investigated the biology of these bacilli. They are short, elliptical rods, somewhat pointed at the ends. He found that if the infected blood was used as a means of inoculating from the animal, it was strongly pathogenic. On the contrary, if the bacilli grown on artificial culture media were used, the pathogenic power diminished with the aid of the culture. It was also found that if the bacilli grown in artificial media were used as a vaccine material, animals were protected from the more pætoyline material.

Another form—the *coccus salivarius septicus*—was found in the sputa of a patient who had puerperal septicæmia. Mice, guinea-pigs and dogs inoculated with it died in from four to six days. The blood contained the cocci isolated or in small groups. In the tissues they were found constantly in thick, nest-like collections. They did not cause purulent inflammation. They grew rapidly on agar-agar, gelatine, blood-serum and bouillon, but did not render them fluid. On potatoes and milk they grew poorly, and developed best at the temperature of the blood. They also developed at a temperature of 8° to 20° C.

The third form—the *micrococcus tetragones*—was found three times. Animals infected with it died in from four to eight days. The most pronounced symptoms were great weakness and feebleness. These cocci were found unusually numerous in the blood and secretions, but most so in the lungs. They grow on all the usual culture media and at the usual temperatures. They are pathogenic to mice and to guinea-pigs, but not to dogs nor rabbits. The pathogenic activity of the cultures was not in any degree affected by their age.

The fourth form—the *streptococcus septo-pyæmicus*—was found three times in sputa of persons who were ill (angina phlegmonosa laryngitis, erysipelas). The sputa were pathogenic; not constantly, however, in guinea-pigs, mice and dogs. The dogs died usually of chronic septicæmia; and the guinea-pigs and mice died with a collection of pus found at the point of infection, which had a tendency to spread through the subcutaneous tissues and muscles. This coccus grows on agar-agar, bouillon and potato. It appears to be identical with the coccus of erysipelas and of phlegmonous and puerperal sepsis.

The fifth form—the *staphylococcus salivarius pyogenes*—was found in an abscess produced by injecting beneath the skin of an animal sputa from a patient suffering from scarlatina anginosa. Besides this, abscesses often develop at the point of injection which contain staphylococci identical with the aureus and albus. The S. salivarius pyogenes differs from these in that it renders culture media fluid more easily. On agar-agar the culture appears whitish gold yellow, the aureus being deep red and the albus snow white. On gelatine it frequently forms a membrane, which is not the case with others. It is very resistant to high and low temperatures.

THE INJECTION OF BACTERIA INTO THE VEINS.

Professor von Foder,[4] of Buda-Pesth, has shown that the power of the blood to destroy bacteria is not diminished by a moderate degree of anæmia; but is lessened by dilution of the blood with water so far that the bacteria are destroyed more slowly and with greater difficulty. Pathogenic bacteria disappeared rapidly from the blood,—in which typhoid bacilli are no longer demonstrable a few hours after injection. In some cases the animals are affected nevertheless by the injected material and die with symptoms identical with those of typhoid. Anthrax bacilli injected in large quantities disappeared in four hours; but within twenty to twenty-four hours they again appeared in the blood and the animal died. During the period, however, in which the blood is apparently free from the bacilli, they are constantly present in the internal organs (spleen, liver, kidneys). Thus it is evident that a pathological development of anthrax does not take place in the blood, but in the internal organs. Anthrax is not a blood disease; but the blood is rather the protector of the organism against the pathogenic bacteria. A very small quantity of anthrax material is not lethal: the rapidity with which this disease is fatal is in direct proportion to the quantity of injected material.

According to Foder, the bacilli injected into the blood are destroyed by it. Some, however, reach the organs and there develop. When the bacilli are found in the blood, the animal is then practically at the point of death. Its doom is sealed.

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